McGraw-Hill
Publishing Company, Inc.
James H. McGraw, *President*
Mason Britton, *Vice-President*

POWER

Editor
Fred R. Low
Associate Editors
C. H. Berry
A. D. Blake

Volume 68 New York, July 3, 1928 *Number* 1

The Detroit Power Show

IN THE early days of the National Association of Stationary Engineers, now become the National Association of Power Engineers, the supplymen and others who attended their conventions vied with one another in entertaining the delegates and attracting attention to themselves and their wares, each in his own fashion.

It soon became evident that a pooling of their exhibits and activities into a real exhibition of power-plant apparatus and supplies would be more in keeping with the growing importance if these occasions would afford means for more effectively providing for the comfort and entertainment of the delegates and for the orderly display of the wares of the exhibitors to a larger audience.

The National Exhibitors' Association was accordingly organized for the purpose of holding such exhibitions in connection with the annual conventions of this Association.

And for years it has worked in friendly co-operation with the National officers and the local committees.

Its exhibitions have been prominent features of the conventions, frequented by the delegates between sessions and visited by the engineers of the convention city and its vicinity.

The display is made up entirely of appliances and materials used by the engineer in his daily work. Many of the delegates and visitors owe their first knowledge of devices that have proved useful to them and economical to their employers to their attendance at these exhibits. The intimate contact with so many present or prospective users of their wares has proved valuable to manufacturers and salesmen in opportunities for the personal explanation of the possibilities of their goods, the correction of misunderstandings and the opening of new prospects.

The next show will be held in connection with the 46th Annual Convention at Detroit, September 10 to 15 inclusive. The Convention Hall is said to have the largest ground floor space of any such building in the nation, with an ample lecture room to accommodate the sessions of the convention. Everything is set to make this the equal of any of the excellent exhibitions that the Association has already staged.

F. R. Low

POWER was founded in November, 1884, by Emerson P. Harris and H. M. Swetland. With it was incorporated a paper called "Steam," which had been started by N. Hawkins in Chicago two years earlier.

A few years later ownership passed to H. M. Swetland and James H. McGraw; then to John A. Hill; and with the consolidation of the Hill Publishing Company and the McGraw Publishing Company in 1917, it became the property of the McGraw-Hill Publishing Company.

Robert Grimshaw was the first editor of "Power." Subsequent editors for short periods were George L. Fowler, A. D. Risteen and Franklin VanWinkle. F. R. Low became editor in 1888, which position he still holds.

The present editorial staff of "Power" is F. R. Low, editor; C. H. Berry and A. D. Blake, associate editors; P. W. Swain, managing editor; and Thomas Wilson, F. A. Annett, F. L. Beers, L. H. Morrison, A. L. Cole, R. B. Purdy and G. L. Montgomery.

Cheap Industrial Power

ONE sure way to generate power cheaper than it can be bought is to keep the industrial plant cheaper than the central station in both first cost and operating cost. With a bit of good engineering and common sense the trick can often be turned.

For one thing the industrial plant designer must avoid aping the large central station. The photographic reduction of designs does not yield good engineering. Duplicating equipment will not do it. The only thing that the small-plant man can wisely copy from the central station is the attempt to achieve perfect adaptation of the means to the end in every detail of the plant and its equipment. This may lead to results that some will call antique or radical, but if the job is done right, it will give the one result that really counts—cheap power.

European Remedies for Turbine Blade Corrosion

ENGINEERS have often experienced trouble from the corrosion of steel blading in turbines. This has generally been more pronounced in turbines that stand idle for a considerable portion of the time.

Corrosion cannot take place in the absence of oxygen. Hence air and oxygen must gain admission to the turbine when corrosion occurs. Little oxygen passes over with the steam from a modern boiler, particularly when the feed is deaërated. In general this oxygen finds its way into the casing through the glands when the turbine is shutting down. If the throttle valve leaks slightly during the shutdown period, conditions will be right inside the turbine for rapid corrosion. The steam will furnish the necessary heat and moisture to promote active electrolytic corrosion in the presence of the oxygen.

German engineers have recognized this source of difficulty, and it is their practice to place two throttle valves in front of the turbine with a free bleeding connection between them that leads to some outlet at atmospheric pressure. They insure in this way that there shall be no steam leakage into the turbine when standing idle. When the turbine shuts down, the stored heat in the spindle body will evaporate any moisture in the casing and the turbine will remain dry unless other steam leaks in.

British engineers have tried a method of injecting small quantities of kerosene or other light oil into the main steam pipe before shutting down the turbine. This becomes smeared over the blades and acts as a protection against corrosion during the shutdown period. Certain oils may prove troublesome in condensers and in boiler feed water.

Possibly there are some of the coatings used in boilers to prevent corrosion that might be modified so that they also could be applied to steam-turbine blading. While there are objections to applying such coatings to blades, the gain from longer operating life might warrant their use, particularly in the case of low use-factor, stand-by machines.

What the People Know They Do Not Fear

POLITICIANS will follow any lead that promises to win votes. That is an axiom. Once the railroads were unpopular. So they became a political issue until the public lost interest. Big business took their place and trust-busting became Washington's favorite indoor sport. And now it is the turn of the utilities.

This sort of thing has become such an old story that one would think no industry could fail to be prepared. And the utility industry, in addition, had the warning of Professor Ripley's articles in the *Atlantic Monthly*. It is probable, therefore, that they realized what was coming, and were, in a measure at least, expecting to become the center of attention.

It must be recognized that an industry that grows so rapidly presents a chaotic appearance to the layman. Indeed, those closely in touch with it must be alert to keep abreast of the changes it represents. So it is small wonder that the seed of distrust, rooted in ignorance of the facts, has grown sufficiently in the public mind to give the demagogue his opening.

But the utility industry should realize that Cæsar's wife must not only be above reproach, but must also be free from suspicion. And the way to avoid suspicion is to make sure that the public understands what is going on, that there is no appearance of hocus-pocus in one's dealing. Following such a course, things can be mended and public confidence restored to a point where clamor leaves it serene.

Know What Each Motor Costs to Operate

AN INTELLIGENT solution of any problem can be reached only by a careful analysis. Otherwise, the answer is hit-and-miss and generally with more misses than hits. Power-factor correction on alternating-current circuits is no exception.

If the power factor of the load is much below eighty per cent, means for improving it are worth consideration. How the correcting should be done requires more than snap judgment, as there are several methods that can be employed, no one of which offers a universal solution. In all cases the power factor can be corrected to any desired value by the installation of a static condenser. Frequently this is the right method to employ, but at times a change in the motor installation will be more economical.

Slow-speed squirrel-cage motors, if partly loaded, have a very low power factor. One or two large motors of this type on the system may reduce the power factor

of the load below a satisfactory value. The proper solution of this problem is not to correct the power factor of the whole load, but to replace the offending motors with the correct type of equipment. Because of their low power factor and efficiency slow-speed squirrel-cage motors are generally expensive machines to operate under any circumstances. When partly loaded, they become even more objectionable.

Each motor should be studied on the basis of what it is doing on the system. If the system load has an eighty per cent power factor and a certain motor has one of forty per cent, the operating cost of that motor should be appraised. When this is done, such a machine will frequently be found to be costing so much that it can be replaced and the cost of the change paid for in a short time by the saving in the power bill. A study of the individual motor loads may reveal some surprising wastes, not apparent from a measurement of the system load.

The Ice Stretcher Arrives

THE sending of a new boy for a board stretcher has been a joke among the carpenters since Noah nailed the first plank on his ark. It is, then, somewhat of a shock to find the Department of Commerce giving this mirth provoker a new disguise and foisting it upon the ice man as an ice stretcher.

According to a Washington press release the simplification experts of the department have discovered that the blocks of ice delivered to the household refrigerator have varying dimensions. Consequently, a new system of measures has been worked out whereby the housewife can detect a shortage of weight by slapping a rule along the edges. As most rules are marked up to twelve inches, the expert insists the block must have its side dimensions equal to twelve inches or aliquot parts of this unit of measure.

On the surface this would, to the uninitiated, seem to be an ideal carrying out of the government's plan of standardization. Unfortunately, few ice plants have cans freezing ice twelve inches wide; cans usually have a width an inch or a fraction thereof less than this amount. Evidently, the ice man must either abandon all his present ice cans or must by hook or crook develop an ice stretcher.

Another old-time joke was the sending of the machinist apprentice after a left-handed monkey wrench. Can it be that this is the kind of wrench the Department of Commerce is using in adjusting the ice man's troubles?

Safeguarding Service to the Central-Station Customer

ONE important phase of central-station electric service is reliability. Interruptions cost the customer heavily and, if frequent, make it difficult for the central station to secure industrial business, no matter how attractive the rates.

The reliability of the central-station generating plant is well established, but the overhead transmission line is not so happily situated. It is subject to disturbances beyond the power of man, and now and then fails. For important industrial districts two or more transmission paths are often provided, to decrease the chances of service interruptions.

The prophets tell us that electricity will bring about the decentralization of industry, that we shall see more and more small isolated plants in out-of-the-way places. What is to be done to safeguard the service to such customers? If they are far from the big centers, duplicate transmission lines will be too costly. Why not study the possibility of installing generating equipment in the plant of the customer? Perhaps the customer will own and operate the outfit, or perhaps the central station will own it and supervise its operation. There are a few cases of such intallations today. The idea should be studied with a view to its further application.

If the customer uses steam for heating and has a boiler plant anyway, the generating set on his premises may be a steam-turbine unit exhausting to his heating load, and it can be run more or less continuously in parallel with the central-station service, power coming in or going out according to the customer's varying demand. If there is no use for exhaust or extracted steam, perhaps some variety of internal-combustion engine can be used. Some of these are adapted to rapid starting in an emergency, and the stand-by costs are low.

Difficulties can be foreseen, but if industry does decentralize, the problem must be solved. Industry cannot run on an intermittent power supply.

A Standard Diesel Fuel

ONE of the main themes of the recent Oil Power Conference at Pennsylvania State College was the desirability of standardizing on a broad liberal fuel-oil specification for Diesel engines.

Those who go into the markets for a supply of oil know how hard it is to obtain a fuel conforming to the specifications recommended by the engine builder. Strict adherence to these recommendations often results in a high-priced fuel.

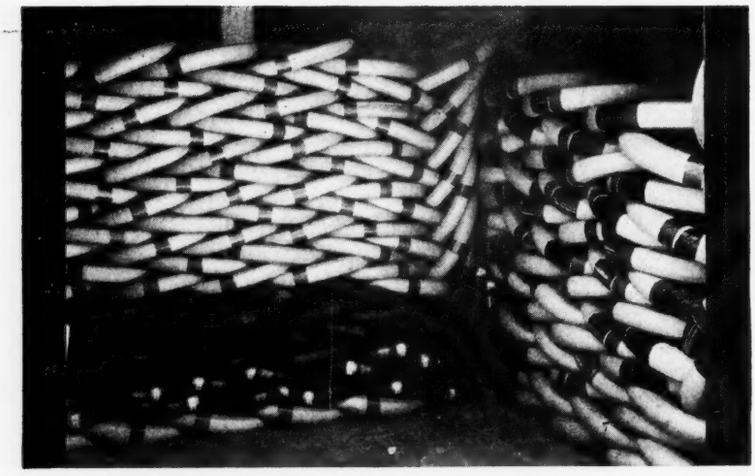
The problem of cheap oil can be solved by a better understanding of the quality of fuel the particular engine can handle. A builder can hardly be blamed if he recommends a high-grade fuel. The engine is going into new and often inexperienced hands. Time has proved that better oil means less care and trouble.

On the other hand, there is a temptation to buy a cheap, inferior oil. The problem of the individual engine owner is the proper balancing of reduced oil costs and increased maintenance charges.

At first glance the solution seems easy. As has been suggested by some, a three-part specification could be worked out, whereby the engine owner could use a high-grade oil, a medium grade or a poor grade, depending upon how important the oil price was to him.

Unfortunately, this is but a part of the solution. If all the engines in use were of one type and were built by one manufacturer, the three-part specification would be sufficient. But the ability of an engine to handle a poor oil depends on its design. An air-injection engine might handle a very inferior oil, while an engine using pump injection and one nozzle in a precombustion cup might fail to function on an oil having far better characteristics.

While the problem is complex, it is possible of solution if the work is properly handled. It will require frankness on the part of both engine builder and oil refiner, and honesty as well as impartiality on the part of those writing the specifications. In short its solution will be certain if the spirit shown at the Penn State Conference is projected into the daily business relations of the oil-engine industry.



A shipment of tires from the Dunlop plant

How POWER SERVICES

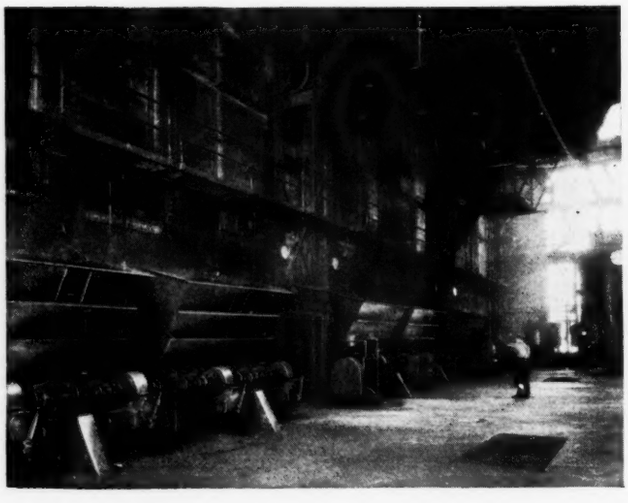
By Graham L. Montgomery
Editorial Staff, Power

TIRE manufacturing is an industry which requires power services in relatively large quantities; steam, electricity, compressed air and hydraulic pressure being the principal services used. The amounts of these services required, in addition to their relation to the output of tires, depend somewhat upon the manufacturing methods employed. For instance, some plants may use relatively more hydraulic pressure and less compressed air than others do. Depending on this relation, and also on the local price of central station current, the set-up for the most economical supply of power services will vary from plant to plant, and must be determined by a thorough investigation of the conditions surrounding any particular installation.

One solution of this problem has been made by the Dunlop Tire & Rubber Corporation, Buffalo, N. Y. This plant was erected in 1921 by a company that already owned tire factories in many other parts of the world and had learned by experience the proper methods to follow in laying out such a plant. Straight-line flow of materials is arranged for in the plant design. The manufacturing buildings are located on both sides of a covered passageway, 80 ft. wide and about 1,300 ft. long. These buildings have their long dimensions at right angles to the passageway. At the right of the manufacturing buildings is the storage building for finished goods with the power house placed just beyond it. The power house is placed off at one side of the plant so that it will be central in the future when the manufacturing plant is extended by duplicating the present layout on the other side of the storage building.

Briefly, the process carried on in the plant is as follows: The storage and preparation of raw materials takes place in the buildings to the left of the passageway as mentioned. Materials enter at the left of these buildings, where the raw material storages are located and pass through the preparation departments toward the passageway. Across the passageway are the buildings in which tires and tubes are manufactured. The vulcanizing and finishing departments are nearest to the storehouse for finished goods so that these can pass directly into this building. Railroad spurs serve the raw material storage, the finished goods storage and the power plant.

Ample space and well-placed instruments help make operating easy



Crude or raw rubber, compounding chemicals and pigments, and cotton fabric are the raw materials of tires. The rubber is received in bales, each bale in a wooden box. The first step is to remove the bale and cut it up into chunks. It is then milled on large, motor-driven roller mills, after which it is rolled into sheets. The final step in its preparation is the milling into these of a mixture of pig-

ments and chemicals, the exact composition of which depends on the grade of rubber and the use for which it is being prepared. The resulting sheets of refined rubber are then ready to enter into the process of tire manufacture.

Cotton is received from the company's mills at Utica, N. Y., in the form of duck or cord fabric, to suit the type of tires being made. It is then passed through mills and calenders in which it is impregnated and coated with rubber.

The rubber and the treated fabric then pass to the other side of the covered passageway, into the tire manufacturing departments. These can be divided into three general groups: solid truck tires, pneumatic tires and tubes. In each of these groups the steps are, in general, the same. The product is first built up or formed, then it is vulcanized or cured, and finally it is finished and packed.

These are, briefly, the steps in tire manufacture. In

Help Make RUBBER TIRES

carrying them out a large number of motor-driven machines are used for processing and for material handling. Steam, air pressure and hydraulic pressure are used in the vulcanizing and curing operation.

At the Dunlop plant, electric current is purchased from the nearby Niagara Falls hydro-electric development. Steam for process use, compressed air, hydraulic pressure and water service are produced in the company's power house. The compressor and pump installations are partly motor-driven and partly steam-engine or turbine-driven, to insure service in emergencies.

The steam generating equipment comprises six B. & W. boilers, each of 6,405 sq.ft. of heating surface. These boilers are equipped with Riley 7-retort stokers. Diamond soot blowers are installed on each boiler. There are six Green economizers, each with 3,570 sq.ft. of heating surface.

Draft, both forced and induced, is supplied by Buffalo Forge fans. The forced-draft fans are driven by Terry turbines and the induced-draft fans by G.E. motors. Combined draft and stoker speed control is accomplished by six Hagan combustion control sets.

The feed water is pumped from the nearby Niagara River by the company's own pumping station, which supplies water for all plant purposes. It is treated in a Cochrane-Sorge water softener of 10,000 g.p.h. capacity. The feed pumps are 200 g.p.m. centrifugal pumps, three in number, made by the Buffalo Steam Pump Company. They are driven by Terry steam turbines. Feed water regulators are of Copes design.

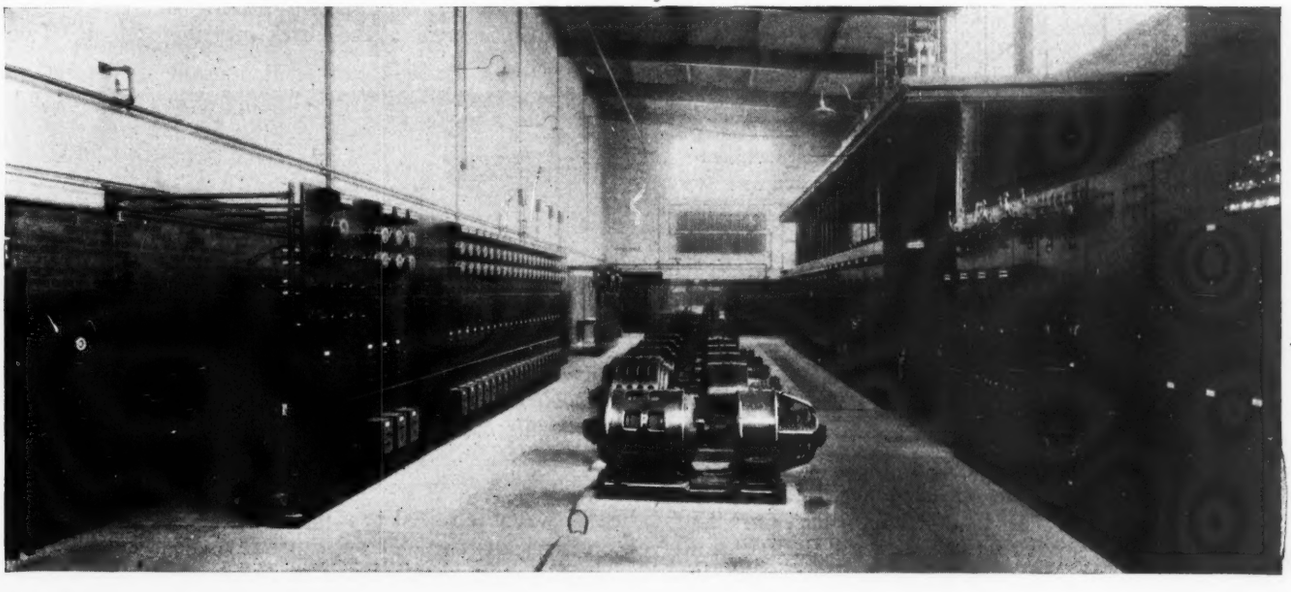
Condensate returns from process are pumped by 3-Dean Bros. duplex pumps of 175 g.p.m. capacity each. These pumps take the return from plant process lines, drips, etc., and pump it to the feed water heater. This heater is an open or direct-contact Cochrane type in connection with the softener.

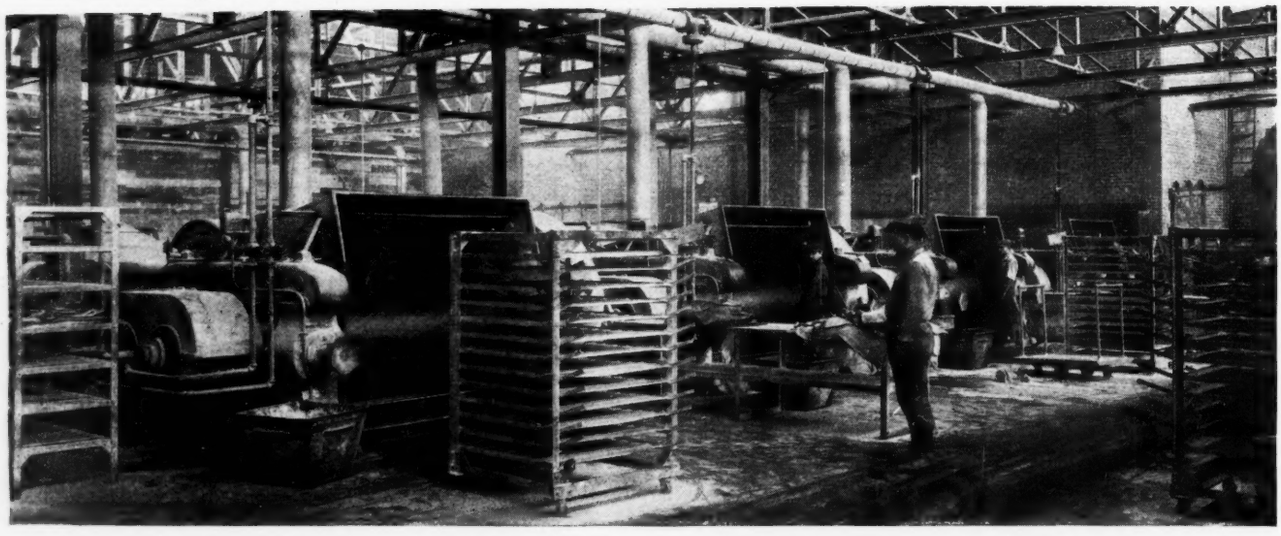
Control is well taken care of by a complete set of instruments. Recording thermometers, CO_2 meters, draft gages, pressure gages, Venturi meters and steam flow meters are supplied in sufficient number to give a complete record and check on the generation and utilization of power services.

Steam is generated at 170 lb. pressure with 100 deg. F. superheat. The high pressure is used for the drive of steam auxiliaries, while, for vulcanizing, a lower pressure is employed. Regulation of process steam pressure is accomplished by regulators installed at the point of application. Building heating is done with exhaust steam, supplemented by live steam when the heating demand exceeds the exhaust supply.

Water is supplied to the plant at three pressures. For cooling and other low-pressure work, the supply is at 30-lb. pressure. Medium-pressure water at 450 lb. is supplied by a motor-driven, 10-stage Allis-Chalmers centrifugal pump of 500 g.p.m. capacity. This unit is

The transformers are behind the wall on the left of this shipshape substation

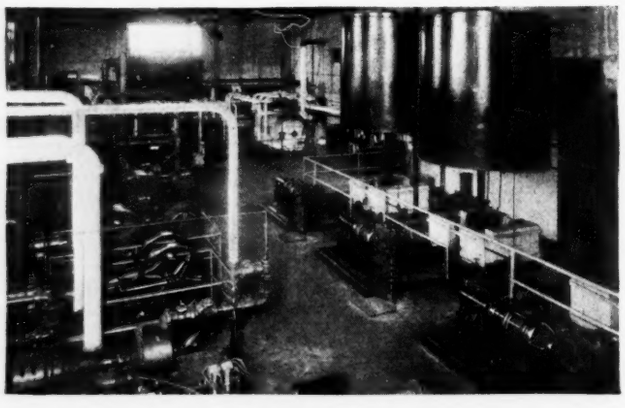




These rubber mills, which are big power users, are driven in batteries of four from 500-hp. motors in the room at the right

equipped with stand-by service from a steam-driven 3-stage Cameron centrifugal. High-pressure water at 1,800 lb. pressure and 20 g.p.m. is supplied by four motor-driven Metalwood pumps. Emergency service at this pressure is afforded by a Union steam pump of 75 g.p.m. capacity.

Compressed air is developed at two pressures, 110 lb. and 220 lb. The low-pressure air is compressed by a steam-driven, Ingersoll-Rand compressor of 1,400 cu.ft. capacity, operating continuously, and an electric-driven Ingersoll-Rand compressor of 327 cu.ft. capacity. The stand-by for this service is a 355 cu.ft. capacity, steam-



Air compressors, hydraulic pumps, water service pumps and auxiliaries are concentrated in one spacious room

driven Ingersoll-Rand machine. High pressure air is compressed by two electric-driven Ingersoll-Rand machines of 272 cu.ft. capacity each, operating at 250 lb. pressure.

Alternating current is used at three voltages; 2,300. 440 and 110. Direct current is used at 230 and 125 volts. The normal load is 3,000 kw., with an average power factor between 91 and 92 and load factor varying from 68 to 51. Current, received at 11,500 volts, is stepped down in 1,000 kva. transformers to 2,300 volts. There are seven of these General Electric transformers, six operating normally and the seventh held in reserve. Substations are conveniently located out in the plant, there being six of these. Lighting current is carried on separate lines to these substations. It is then stepped down to 110 volts and carried on a loop system allowing for emergency tie-in.

For power there are two cables feeding each substation. In the substations this current is transformed to 440 volts, except for a certain amount that is used at 2,200. Direct current is obtained from motor-generator sets located in substations adjacent to the point of use. In general, all of the electrical equipment was made by the General Electric Company.

Steam is used for driving auxiliaries, for vulcanizing rubber and for building heating. In the ordinary vulcanizing operation, steam at 175 lb. pressure is reduced at the vulcanizer by means of a reducing valve, to 90 lb. This 90-lb. steam is then fed to the vulcanizer at a constant temperature of 293 deg. F. by means of a Tag-Roesch controller, actuated by low-pressure compressed air.

Steam is also used for heating water for the vulcanizers that use hot water under pressure in place of air as an inflating medium. In this process water is heated by 125 lb. steam to 306 deg. F., in a tank equipped with coils. A receiving tank takes the condensate from these coils, which is then pumped back into the system. The

Rubber tires are largely cotton cloth and it takes this heavy equipment to impregnate and calender the fabric

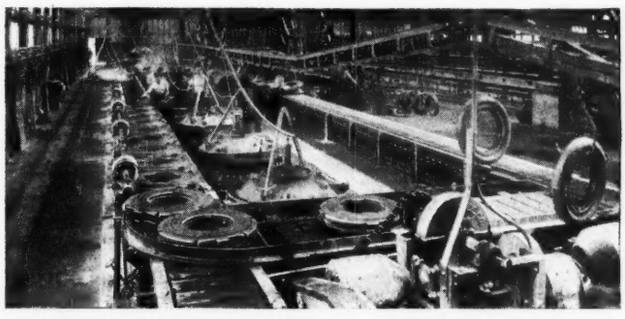
heated water is raised to a pressure of 300 lb. per sq.in. by means of two Union duplex steam pumps. An accumulator is installed in the line between the pumps

and the vulcanizers, to maintain a constant pressure. Other equipment used in this system comprises two motor-driven centrifugal circulating pumps, two Frank heaters, two Blackburn-Smith filters and a supply tank. Vulcanizers using hot water operate at 293 deg. F., maintained by means of Tycos control.

Building heating is taken care of by the exhaust steam from the auxiliaries and vulcanizers, except that the buildings farthest from these sources require live steam also during cold weather.

Water at 30 lb. pressure is used for cooling water and general plant purposes. Medium-pressure water at 400 lb. serves rams, heaters and vulcanizers. High-pressure water, 1,800 lb., operates the final vulcanizing processes and the presses. Hydraulic pressure at 400 lb. is also used for operating the equipment for loading and unloading the heaters and vulcanizers, and for opening molds.

A general plant water supply is also available from an overhead tank, giving about 30 lb. pressure through the plant. This is supplied from the river by two Goulds

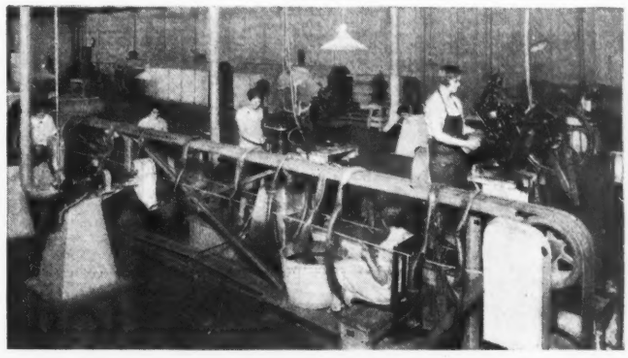


Steam, compressed air, hot water and electricity are used in vulcanizing and curing tires

centrifugal pumps of 2,500 g.p.m. capacity each, ordinarily supplying a total of about 3,500 g.p.m. to the receiving tank. Drinking water is obtained from the city supply, about 1,500,000 gal. per month being used.

Compressed air at 110 lb. is used for small machine operation and general process purposes. High-pressure air at 220 lb. is used in the vulcanizing process. It is fed in through the top of the heater or vulcanizer and distributed to each individual tire, which is thus kept fully expanded during the curing.

Alternating current at 2,300 volts is used for driving large mill motors; for instance, there are eight 500-hp. synchronous motors running at 100 r.p.m. Most of the small motors used in tire making use 440-volt a.c. while the lighting circuits take 110 volt a.c. Direct current drives the calenders and the fabric coating mills, which



Inner tubes must be carefully finished and tested to insure satisfactory performance

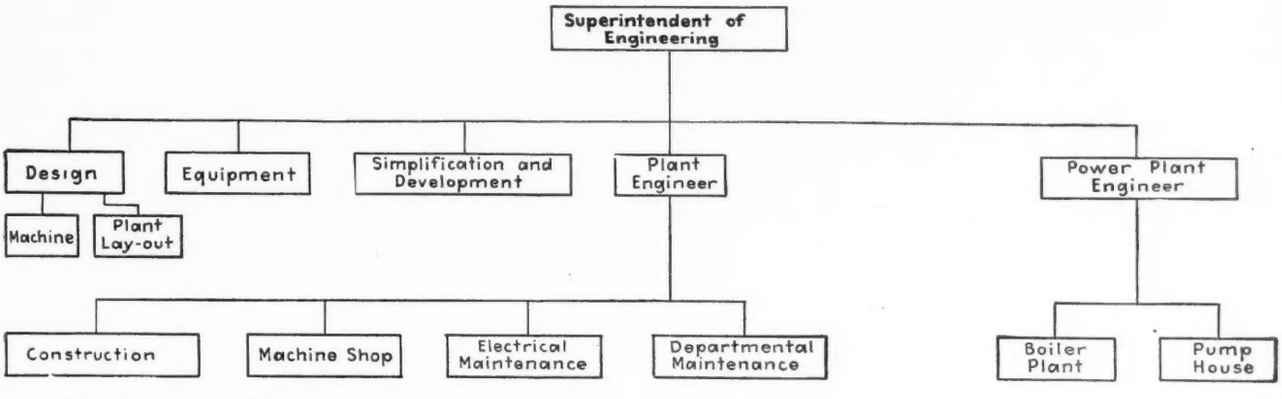
require four 100-hp. motors. The conveyor motors and the motors on the machines for core-built tires are also d.c.

Approximately 1,000,000 lb. of steam are used per day, developed from the combustion of 50 tons of coal with an average evaporation of 9.5 lb. per pound of coal. The process load is 72 per cent or 720,000 lb. steam per day, while 280,000 lb. are used for operating pumps, compressors and auxiliaries. The heating load is 40 per cent of the total; leaving 32 per cent, or, at 175 lb. pressure and 100 deg. F. superheat, 401,152,000 B.t.u. for process work. With a capacity of 12,000 tires per day, the processing of a tire requires, on the average, 33,430 B.t.u. The building heating load is continued throughout the summer, although not to the same extent as in winter. This is to keep the working rooms dry, a necessary procedure in tire making. Only in July and August is there an excess of exhaust steam, and this excess is small. At other times the heat utilization is approximately complete.

The consumption of electricity approximate 1,000,000 kw.-hr. per month, of which 20 per cent is converted to d.c. Although some of this can be directly charged to the operation of boiler-room auxiliaries and some to the development of air and water pressure, it is all ultimately chargeable to tire production.

The organization by which the power services are controlled and supplied to the production departments is shown in the accompanying diagram.

Organization chart of the Dunlop engineering department. Department maintenance men receive instructions as to order of work from department superintendents and as to methods and details from the plant engineer



An Electric Railway

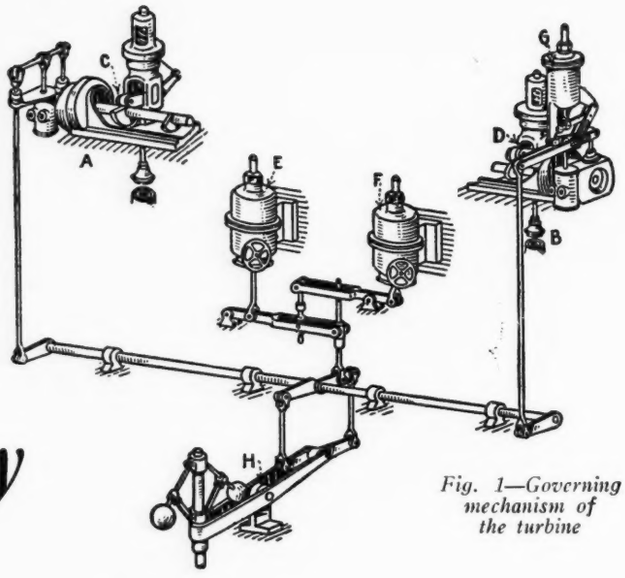


Fig. 1—Governing mechanism of the turbine

STORES STEAM

A modern steam accumulator displaces storage batteries and banked boilers at the Hamburg Elevated Railway Plant

BY DR. ING. W. MATTERSDORFF

WHEN the first section of the Hamburg (Germany) Elevated Railway power station was placed in service during 1912, substation peak loads were carried with the aid of storage batteries, and at least one banked spare boiler was held in reserve at the generating plant.

The original boiler equipment consisted of six 4,200-sq.ft. units that supplied steam to one 4,000- and two 2,000-kw. turbines. Later, two 5,500- and two 7,500-sq.ft. boilers were added. It is now planned to replace two of the old 4,200-sq.ft. units with two 6,000-sq.ft. boilers to meet the increased demand for steam by the revised and enlarged turbine room, which will contain two new 10,000-kw. accumulator steam turbines, as well as one 6,000-kw. and one 4,000-kw. standard-type turbines.

Two Ruths steam accumulators, having a total capacity of 11,635 cu.ft., have been installed and are now a part of the heat balance of the station. The flow diagram shown in Fig. 2, which is simplified to include only one boiler, one accumulator and one turbine, illustrates the schematic arrangement. This system also delivers steam to the car barns for heating purposes in the cold months of the year.

The new 10,000-kw. accumulator turbine differs materially from the better-known mixed-pressure type in that it is capable of operating at all required ratings with steam drawn from an accumulator at a variable pressure. The turbine contains two velocity stages, five constant-pressure and five excess-pressure stages, and is capable of operating either with superheated steam from the boilers or with saturated steam from the accumulators at a pressure that may vary between 220 and 74 pounds.

As the first-stage rotor is of the Curtis type, it may be independently supplied with live and accumulator steam at the same time, which means that accumulator steam will also pass through the turbine. Fig. 3 shows the steam-inlet casing and nozzle arrangement, the high-pressure nozzles being at the top and the accumulator-steam nozzles at the bottom.

The method of governing the turbine is illustrated in Fig. 1. When an increase in load reduces the turbine speed, the governor first responds by admitting live steam through *A*. If this increased steam demand causes the boiler pressure to drop, the live-steam pressure regulator *E* admits enough additional accumulator steam to the turbine to restore the boiler pressure to within its normal limits. The secondary regulating valve *G* automatically adjusts the size of the openings through which accumulator steam is admitted to maintain the turbine output under variable pressure.

The governor valve *E* cuts the accumulator out of service when the discharge pressure reaches 74 lb. However, as this low limit occurs only during high overloads, and it is still possible to swing extreme peaks of short duration by allowing the accumulator pressure to drop another 15 lb., it was decided to set the governor of the new 10,000-kw. turbine for a minimum discharge pressure of 37 lb. It is not intended to allow this low pressure to be reached in regular operation, but the change in pressure drop between 74 and 37 lb. will serve as a reserve capacity to swing momentary overloads. All pressure values are in pounds per square inch absolute.

The curve in Fig. 4 shows the output of the turbine with the accumulator discharging over its entire pres-

sure range. The accumulators, with a total capacity of 11,653 cu.ft., will deliver 3,650 kw.-hr. at a pressure drop from 220 to 74 lb., and will increase this output to 4,800 kw.-hr. if the discharge pressure is allowed to drop to 37 pounds.

Although the accumulator will neither charge nor discharge at the average boiler pressure of 192 lb., the

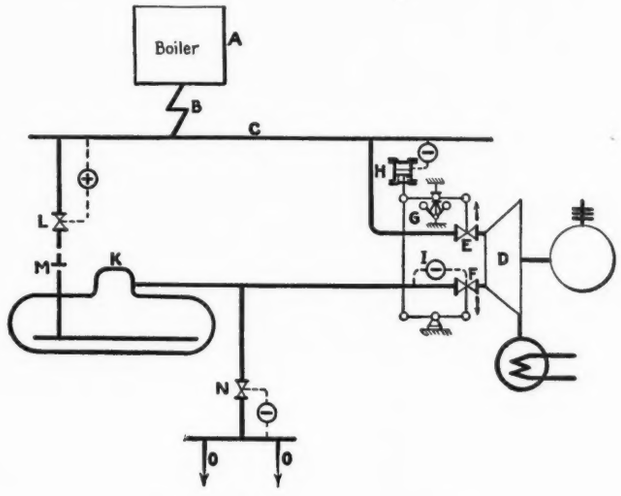


Fig. 2—Diagram of steam flow

A, boiler; B, superheater; C, steam mains; D, turbine; E, live steam inlet; F, accumulator-steam inlet to turbine; G, governor; H, live steam regulator; I, secondary governor; L, oil-actuated accumulator charging valve; M, charging valve; N, live steam reducing valve; O, steam heating lines.

charging valve will open when the pressure rises beyond this point. When the boiler falls below this value, the accumulator automatically discharges to the turbine until the boiler pressure is restored.

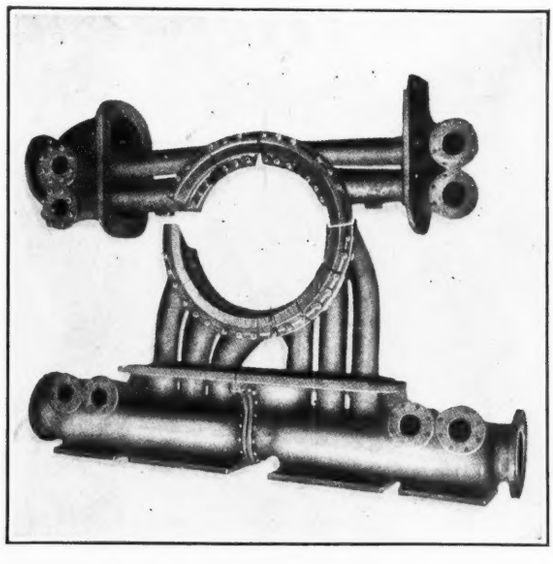


Fig. 3—Live and accumulator steam inlets to the turbine

The steam connections to the pressure-recording gages, the governor-regulating valve and the accumulator-charging valve are tapped into the boiler-room main at some distance from the boilers. This location assists materially in regulating the maximum working pressure of the boilers, because the varying pressure drop between the boilers and the turbine, due to changing load, is practically neutralized between the charging and discharging of the accumulator.

The live-steam pressure at the turbine never drops below 184 lb. abs. and does not rise beyond 203 lb. Thus nearly constant working pressure has simplified boiler-room operation.

The following instances illustrate how the functioning of the accumulator offsets service troubles: Following a breakdown of the stoker drive under one 7,500-sq.ft. boiler, which occurred at 5:30 a.m., too little time was available to fire up and cut in a fresh boiler, and the accumulator was called upon to make up the deficiency in steam. It discharged rapidly between 6 and 7 a.m., with a pressure drop from 206 to 88 lb. Toward 7 o'clock the electrical load fell off slightly, which allowed the boiler pressure to recover and for the next 40 min. it was possible to operate the turbine with the boiler pressure approximately equal to the accumulator pressure. In the meantime the accumulator discharge valve

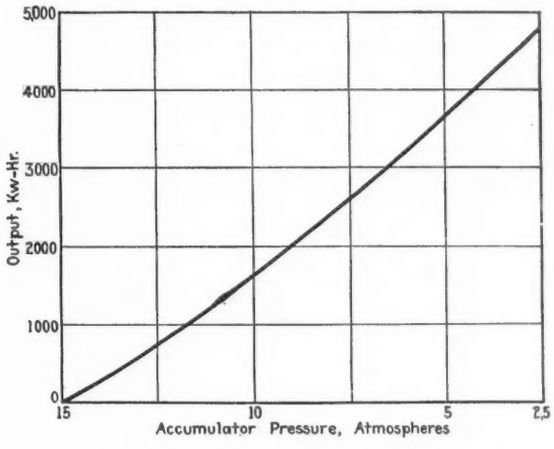


Fig. 4—Turbine output and accumulator pressure drop

closed automatically as the minimum pressure for which it had been set was reached. As the boilers were still unable to generate sufficient steam, the limit stop on the governor-regulating valve was adjusted by hand to allow the accumulator to continue to discharge down to 52 pounds.

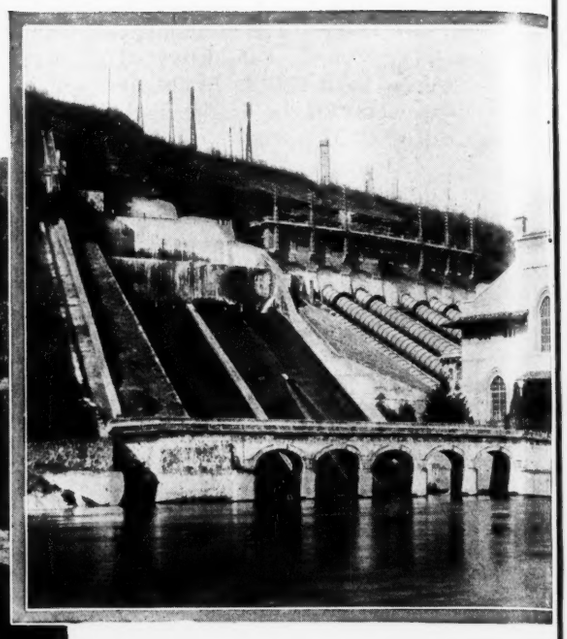
On Oct. 31, 1927, the neighboring plant required 4,000 kw. to meet an emergency, which was delivered by the accumulator without trouble while a fresh boiler was being fired. When, after 50 min., this boiler was steaming at the rate of 7.2 lb. per sq.ft per hour, the accumulator pressure had dropped to 95 lb. When the load fell off, the surplus steam from the extra boiler was delivered to the accumulator, making it unnecessary to blow down the boiler to waste.

AVERAGE COAL CONSUMPTION

Year	Lb. per Kw.-Hr.	Remarks
1923	2.53	Before accumulator installation
1924	2.51	Before accumulator installation
1925	2.43	Accumulator used for heating only
Jan., 1926, to Oct., 1926	2.31	Accumulator used for heating only
Oct., 1926 to Sept., 1927	1.99	After first accumulator turbine was placed in service.

Since a compound oil will not evaporate before decomposition sets in, deposits will form on the walls of an air-compressor cylinder. Only a pure mineral oil should be used. The mineral oil should always be a filtered stock.

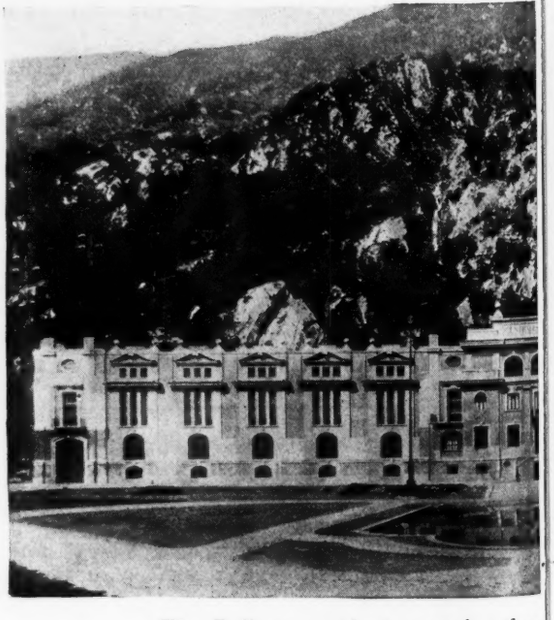
(Below) Calusco, one of the three low-head plants on the Adda River, having an aggregate installed capacity of 59,900 hp. and using water from Lake Como



The plants shown on this page are included in the itinerary of the International Power Tours of the Midwest Power Conference which sails from New York, Aug. 18 of this year. These plants are operated by the Milan Edison Company (Societa Generale Italiana

MILAN-
Hydro-Electric

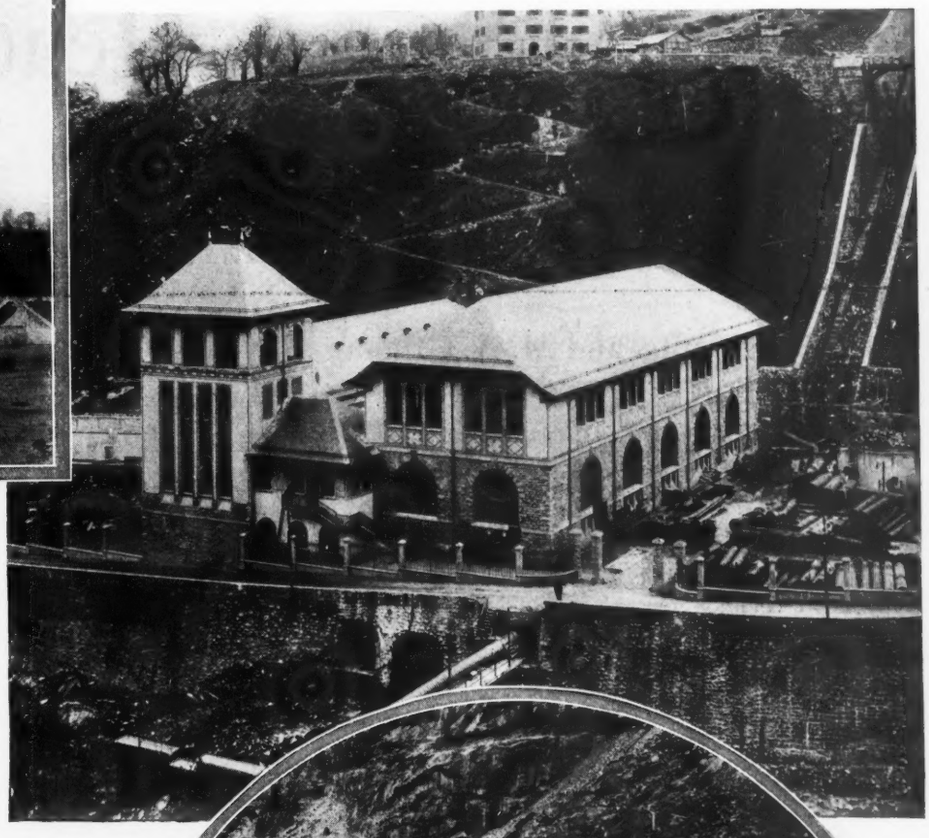
(Above) Interior of the Robbiate station on the Adda River. In this plant there are six 6,300-hp. horizontal-shaft units, two of which generate 16.7-cycle current for railway service



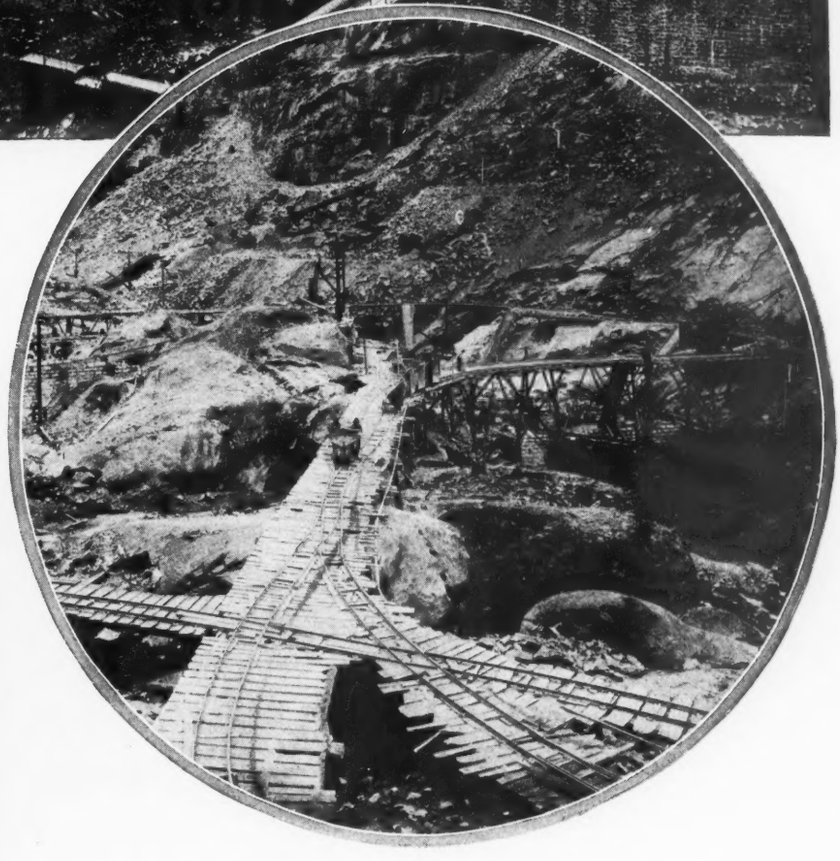
The Pallanzeno plant, contains three 13,000-hp. units operating under a 1,700-ft. head and using the water dis-

Edison di Elettricita), and are in two groups, low-head projects on the Adda River near Milan, and high-head stations in the Antrona Valley south of Domodossola. Above is shown the Robbiato station rated at 37,000 horsepower and a static head of 128 feet

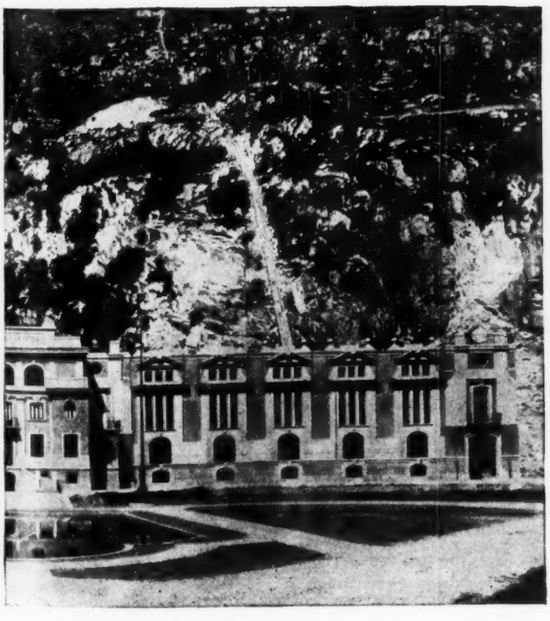
(Below) Rovesca plant is supplied from three sources, under heads of 2,340, 1,700 and 820 ft. respectively. There are five units of 55,000-hp. total capacity.



EDISON
Power Plants



(Above) Constructing the Alpe Camplicciоli dam, which will form one of the three reservoirs to supply the Rovesca plant. The water level will come up to near the top of the picture



charged from the Rovesca plant together with water diverted at this plant from the Ovesca River.

A Method for Calculating

Central Station Heat Balance

This article presents a simplified method of calculating a heat balance for a proposed power station, indicates the data required, and tells how to obtain it

By E. B. Hyde Jr. and M. A. Guigou

Assistants to the Mechanical Engineer,
The New York Edison Company

ONE of the early problems that must be solved when a new power station is being designed, is the station heat balance. The method presented in this article for performing these calculations is believed to be less complicated than most of the other methods in common use. The following assumptions have been made in the example worked out to illustrate this method:

The proposed installation shall be a 30,000-kw. turbo-generator with its auxiliaries as described, taking steam at the throttle at 325 lb. per sq.in. gage pressure, with 200 deg. of superheat, a total temperature of 629 deg. F.

No economizer is considered, as the feed water is to be heated by the exhaust steam from the steam-driven auxiliaries and from steam bled from three stages of the

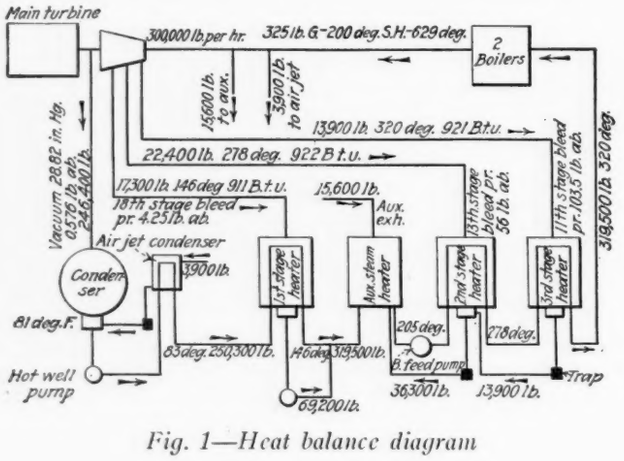


Fig. 1—Heat balance diagram

turbine. The boilers are to be supplied with air heaters for preheating 80 per cent of the air furnished for combustion. The calorific value of the coal is assumed to be 14,000 B.t.u. per lb. with 15 lb. of gas, resulting from the combustion of 1 lb. of coal.

It is assumed that the installation is to be arranged as shown on the outline drawing, Fig. 1, and shall consist of the main turbine and condenser, one 50,000-g.p.m. circulating pump, one air ejector and one hotwell pump. The turbine shall be connected to two boilers of 20,000 sq.ft. heating surface, each boiler to have its own forced-draft and induced-draft fan. One feed pump is to supply both boilers. In an actual case several manufacturers would submit their bids, the characteristics of their equipment would be obtained and a comparison made. In the case considered it will be assumed that the various units of equipment are selected.

The following data must be obtained from the makers:

The Main Turbo-Generator

The first four items should be given for varying amounts of steam passing through the turbine.

(a) Steam pressures at the bleed stages, Fig. 13.
(b) Steam pressures at the turbine bowl, Fig. 10.
(c) Temperature rise in condensate due to steam jet and gland sealing steam, in this case 3,900 lb. per hour, Fig. 11. The heat available for heating feed water in the gland sealing steam is 1,130 B.t.u. per pound.
(d) Stage efficiencies. Excluding generator and sealing steam losses. (Stages 1 to 14 incl., 86.8 per cent; 18th stage, 84.8 per cent; turbine efficiency to exhaust, 82 per cent.)
(e) Generator efficiency, Fig. 12.

Auxiliaries

(f) Hotwell pump and turbine characteristics, Fig. 7.
(g) Circulating pump and turbine characteristics, Fig. 6.
(h) Feed water pump and turbine characteristics, Fig. 2.
(i) Induced-draft fan turbine characteristics, Fig. 8.
(j) Forced-draft fan turbine characteristics, Fig. 9.
(k) Boiler characteristics, Fig. 3.
(l) Terminal difference condenser, Fig. 16.

With the foregoing information obtained the remaining tables and curves may be calculated and plotted.

In order to find the amount of steam used by the induced-draft and forced-draft fan turbines, Table I was calculated. This assumes that the boilers are of 20,000 sq.ft. heating surface each and that the second boiler is cut in when the rating of the first approximates 300 per cent (see Col. 4).

TABLE I—GAS AND AIR QUANTITIES

1	2	3	4	5	6	7	8	9	10	11
Lb. Steam per hour at Throttle	Feed Temp.	Rating* Per Cent.	No. Boilers	Eff. Per Cent.	Lb. Coal per Hour	Lb. Gas per Hour	Temp. Gas	Lb. Air per Hour	Cu. ft. per Minute	
									Gas	Air
100,000	250	181	1	85½	10,150	152,000	300	122,000	48,500	27,000
150,000	277	265	1	85½	14,900	223,000	375	179,000	77,500	40,000
200,000	295	348	1	82	20,300	305,000	440	244,000	115,000	54,500
200,000	295	174	2	85½	19,500	292,000	295	234,000	92,500	52,000
250,000	312	216	2	86	24,000	360,000	330	288,000	119,000	64,000
300,000	323	255	2	85½	28,500	427,000	360	342,000	147,000	76,000
350,000	334	294	2	84	33,500	503,000	395	402,000	180,000	89,000

* Including 10 per cent additional steam for auxiliaries.

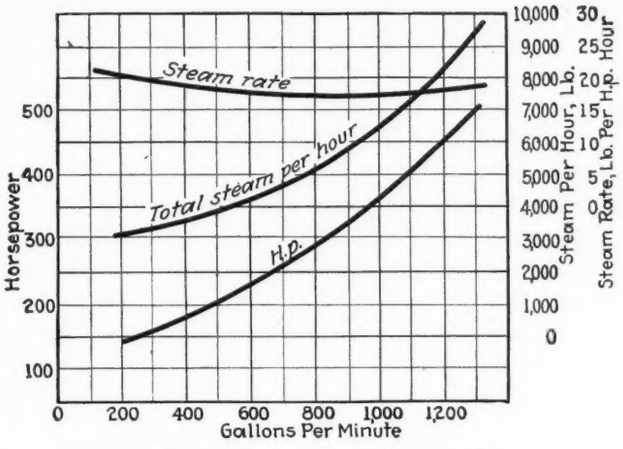


Fig. 2—Feed pump steam consumption

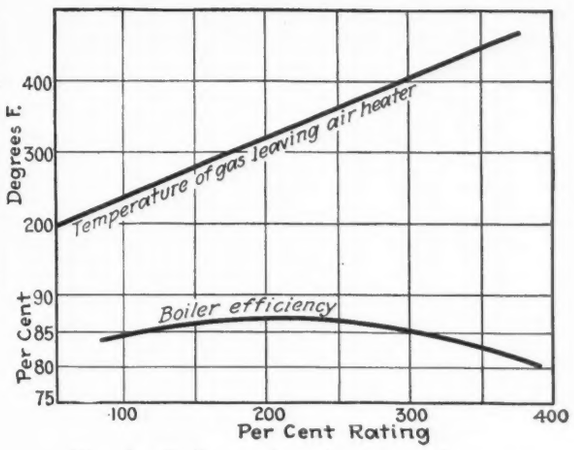


Fig. 3—Boiler and preheater performance

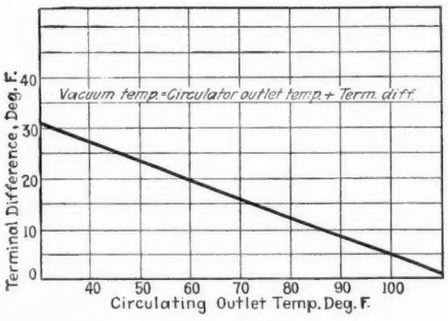


Fig. 4—Terminal differences for condenser

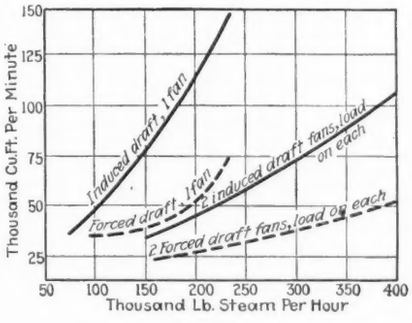

Induced draft, 1 fan
Forced draft, 1 fan
2 Induced draft fans, load on each
2 Forced draft fans, load on each
Thousand Cu.Ft. Per Minute
Thousand Lb. Steam Per Hour

Fig. 5—C.F.M. at various steam flows

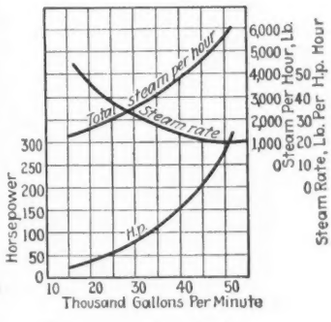


Fig. 6—Circulating pump

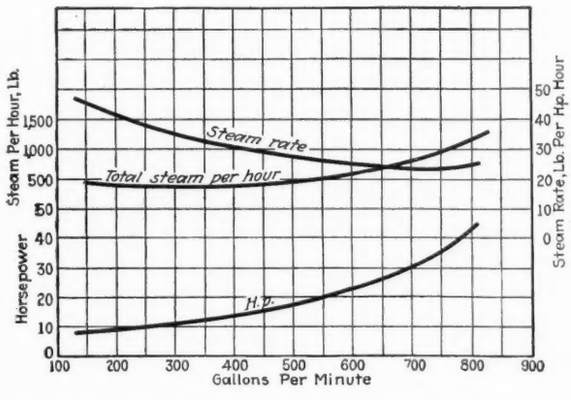
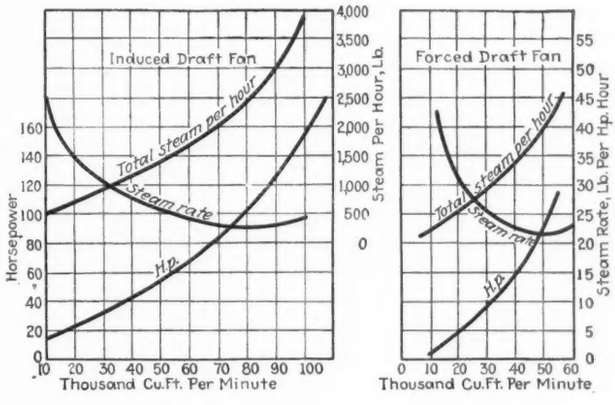


Fig. 7—Hotwell pump steam consumption



Figs. 8 and 9—Steam consumption, fans
Center and right-hand scale refers to both figures

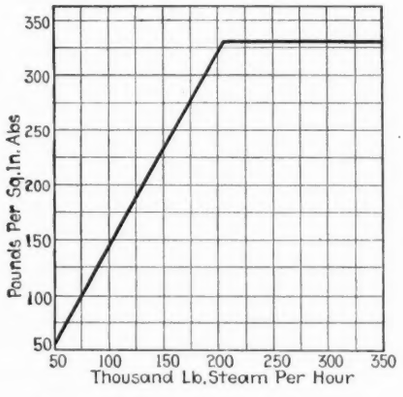


Fig. 10—Turbine bowl pressure

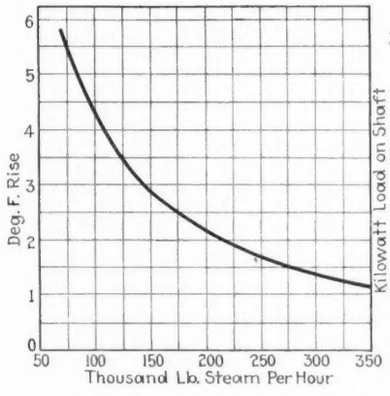


Fig. 11—Temp. rise of condensate

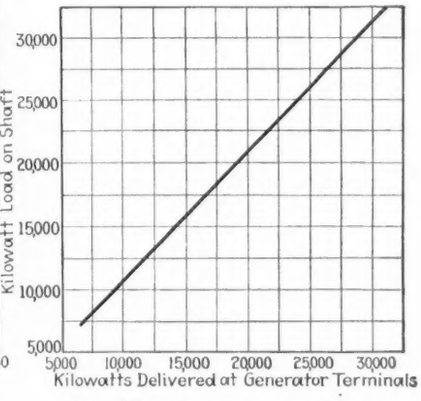


Fig. 12—Generator performance

Suppose it is desired to find the amount of gas and air passing through the boiler when generating 150,000 lb. of steam for the main turbine.

To 150,000 lb. of steam add 10 per cent, which is an allowance for the steam consumption of the various auxiliaries, thus making 165,000 lb. of steam to be generated. The temperature of feed water (Col. 2) is found by consulting Fig. 13 and finding that at a flow of 150,000 lb. of steam the pressure at the highest bleed point, or 11th stage, is 55 lb. absolute. The temperature corresponding to this pressure is 287 deg. Since it has been assumed in these calculations that the feed water will be raised to within ten degrees of the saturation temperature corresponding to the pressure of the bleed steam, the feed water temperature will therefore be approximately 277 deg. The temperature of the highest bleed point, of course, determines the temperature of the feed water at the load under consideration.

The boiler rating may now be obtained as follows: The total B.t.u. in one pound of steam is 1,323. With feed water at 277 deg. F. each pound of water receives 1,323 — (277 — 32) = 1,078 B.t.u. and the boiler rating is $\frac{165{,}000 \times 1{,}078}{2{,}000 \times 33{,}500} = 265$ per cent. With the rating known, the boiler efficiency (Col. 5) is found by consulting the curve in Fig. 3, and in our example at 265 per cent the efficiency is 85½ per cent. The amount of coal burned (Col. 6) is

$$\frac{165{,}000 \text{ lb. steam} \times 1{,}078 \text{ B.t.u.}}{14{,}000 \text{ (B.t.u. per lb. of coal)} \times 0.855} = 14{,}900 \text{ lb.}$$

The pounds of gas resulting from combustion (Col. 7) is equal to the pounds of gas per pound of coal multiplied by the pounds of coal, or Col. 6 × 15. Knowing the boiler rating, the temperature of the gas leaving the air heater (Col. 8), which is the temperature of the gas handled by the induced-draft fan, is found by consulting the curve in Fig. 3. In our example at 265 per cent rating this temperature is 375 deg. The amount of air required for combustion is equal to the pounds of coal multiplied by the pounds of air per pound of coal, or Col. 6 × 12. The volume of gas and air to be handled per minute by the fans may be found by dividing the weights of gas and air per minute by their densities at their respective temperatures. These values are given in Cols. 10 and 11.

Table I can now be completed and the curves shown in Fig. 5 drawn.

Finding Amount of Steam Taken by Turbines

The amount of steam taken by the induced- and forced-draft fan turbines can now be found by consulting the curves in Figs. 5, 8 and 9. Following our example of 150,000 lb. of steam, the induced-draft fan will handle 76,000 cu.ft. of gas per minute, Fig. 5, and by looking at the induced-draft fan curve, Fig. 8, it will be found that the amount of steam used by the driving turbine is 2,250 lb. per hour. The steam used by the forced-draft fan turbine is found in a similar manner.

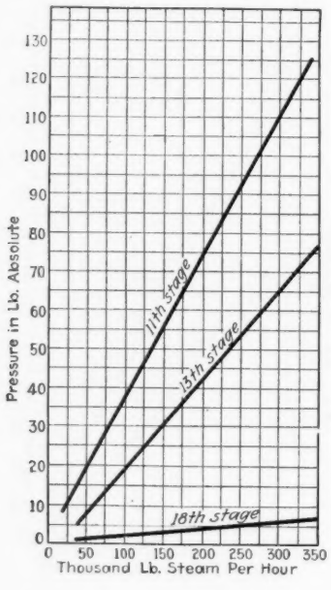


Fig. 13 — Stage pressures for 30,000-kw. turbine

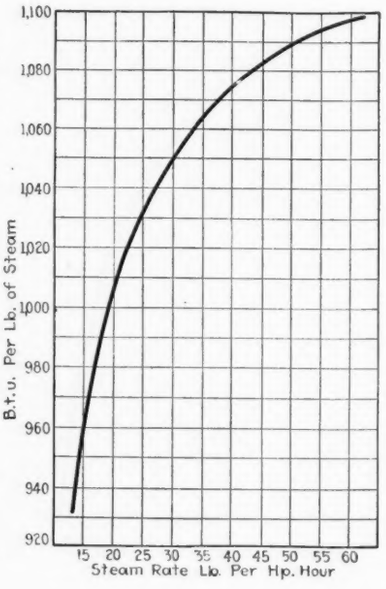


Fig. 14—Available B.t.u. in auxiliary exhaust steam

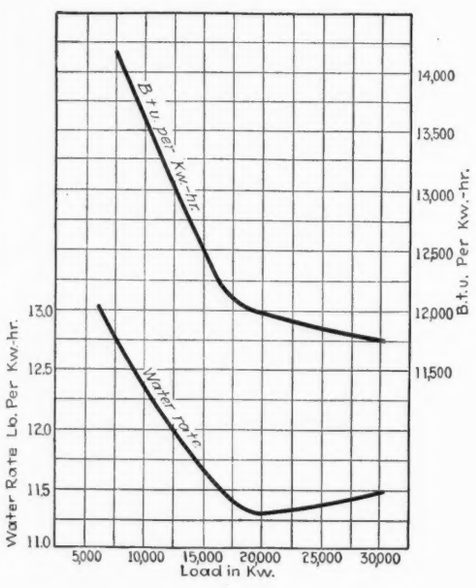


Fig. 15—Plant performance at various electrical loads

Table II gives the vacuum obtained under varying amounts of steam exhausted to the condenser per hour and gallons of circulating water per minute at different temperatures. Assuming that the steam gives up 1,000 B.t.u. per lb. in condensing, the rise in the circulating water temperature can be computed as follows: When 40,000 g.p.m. of water at 60 deg. F. is circulated through the condenser, its weight per hour is 20,000,000 lb. The heat absorbed by this amount of water if it is assumed to condense 100,000 lb. of steam per hour, is 100,000 ×

TABLE II—CONDENSER VACUA UNDER VARYING LOADS AND CIRCULATING WATER

G.P.M.	35 Deg. F T.D.	35 Deg. F Vac.T.	35 Deg. F Vac.	55 Deg. F T.D.	55 Deg. F Vac.T.	55 Deg. F Vac.	75 Deg. F T.D.	75 Deg. F Vac.T.	75 Deg. F Vac.
200,000 Lbs. of Steam per Hour									
20,000	21	76	29.10	14	89	28.62	6½	101½	27.98
30,000	23½	71½	29.22	16	84½	28.81	9	97½	28.21
40,000	25	70	29.26	17½	82½	28.88	10	95	28.34
50,000	26	69	28.28	18½	81½	28.91	11	94	28.39
250,000 Lbs. of Steam per Hour									
20,000	19	79	29.00	12	92	28.49	4½	104½	27.79
30,000	22½	74	29.15	15	86½	28.73	8	99½	28.10
40,000	24½	71½	29.22	17	84½	28.81	9½	97	28.24
50,000	25½	70½	29.24	18	83	28.86	10	95	28.24
300,000 Lbs. of Steam per Hour									
20,000	17½	82½	28.88	10	95	28.34	...	...	...
30,000	21	76	29.10	14	89	28.62	6½	101½	27.98
40,000	23	73	29.18	15½	85½	28.77	8	98	28.18
50,000	24½	71½	29.22	17	84	28.83	9½	96½	28.26

1,000 B.t.u. = 100,000,000 B.t.u., and the temperature rise is $\frac{100,000,000}{20,000,000} = 5$ deg. This rise added to inlet temperature gives an outlet temperature of 65 deg. F.

By consulting Fig. 4, it will be found that for a 65-deg. outlet temperature, the terminal difference is $17\frac{1}{2}$ deg. This added to 65 deg. makes $82\frac{1}{2}$ deg., the temperature of the vacuum.

Upon reference to the steam tables it will be found that $82\frac{1}{2}$ deg. corresponds to a vacuum of 28.88 in. of mercury. In this manner the table was computed, and from the table the curves shown in Fig. 16 were drawn.

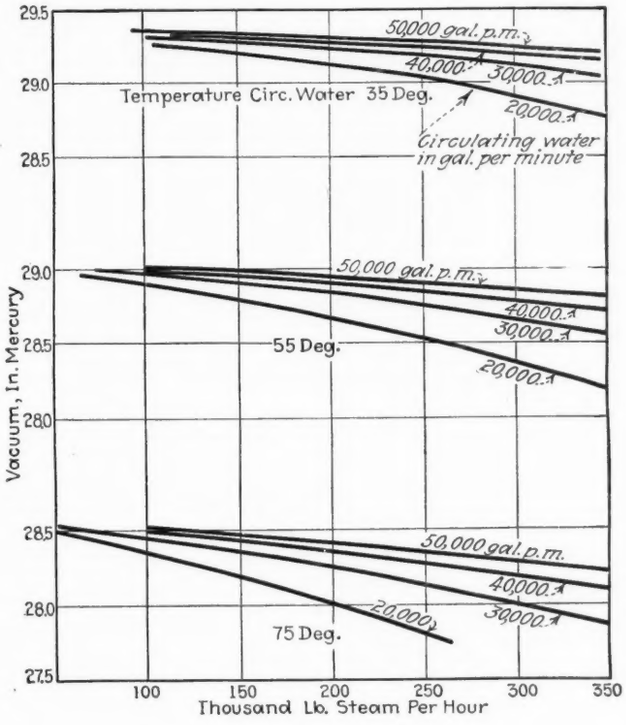


Fig. 16—Condenser performance

The heat per pound of auxiliary exhaust steam that is available for heating feed water is shown by the curve in Fig. 14. The data necessary for plotting this curve were obtained as indicated in the following example, which assumes an auxiliary turbine steam rate of 30 lb. per hp.-hr. The heat per pound of steam converted to useful work is $\frac{2,546}{30} = 85$ B.t.u., and the assuming 10 per cent for radiation and other heat losses, the actual heat drop is $\frac{85}{0.90}$ or say 94 B.t.u. Since the heat in the entering steam is 1,323 B.t.u., the available heat in the exhaust is 1,323 — (94 + 180) = 1,049 B.t.u. (180 B.t.u. is the heat of the liquid at atmospheric pressure and is not available for heating feed water). Similar values found for various steam rates were used in plotting Fig. 14.

TABLE III—AUXILIARY EXHAUST STEAM

1 Auxiliary Turbine	2 Lb. Steam per Hour	3 Steam Rate	4 B.T.U. per Lb.	5 Total B.T.U.
(660-g.p.m.) Feed pump	4,500	18.0	986	4,440,000
(480-g.p.m.) Hotwell pump	450	30.0	1049	470,000
I. D. Fan	4,200	23.0	1022	4,300,000
F. D. Fan	2,600	23.5	1024	2,660,000
(40,000-g.p.m.) Circulating pump	3,800	25.9	1031	3,820,000
	15,550			15,690,000

Heat Balance Calculations

The method of determining the effect of bleeding on the steam cycle of the turbine is one of successive approximations. Although this may seem somewhat cumbersome for a single case, when applied to a complete station heat balance, it nevertheless works out very nicely. The determination of conditions with 300,000 lb. of steam passing through the throttle per hour and a circulating water temperature of 55 deg. F., involves three approximations. Comparison of the second and third approximations shows that for most requirements the second approximation is sufficiently accurate.

The quantity of steam extracted by bleeding at a stage is determined as follows: Let

x = Steam extracted at bleed, lb. per hour.
A = Steam passing through turbine to bleed point, lb. per hour.
B = B.t.u. per lb. available in bleed steam for feed water heating.
R = Rise in temperature deg. F. of condensate in bleed heater.
M = Steam of gland sealing and steam jet pumps in lb. per hour.
E = Auxiliary exhaust condensate lb. per hour.

Then $x \times B = (A - x + M + E)R$ = B.t.u. per hour transmitted to feed water and $x = \frac{(A + M + E)R}{B + R}$

Of the quantities on the right-hand side of the equation, A is assumed for this example to be 300,000 lb. per hour; M, as stated before, is 3,900 lb. per hour, and R, B and E are calculated.

TABLE IV—CIRCULATING PUMP DATA

1 G.P.M.	2 Lb. Steam	3 S. R.	4 In. Hg.	5 Ab.	6 H	7 Adiabatic Drop
30,000	2600	33.5	28.75	.542	883	440
40,000	3800	25.0	28.82	.576	880	443
50,000	5650	20.0	28.89	.610	877	446

The first of these unknowns to determine is the quantity of auxiliary exhaust. Assuming auxiliaries use 10 per cent, the feed pump will handle 330,000 lb. per hour, or 660 g.p.m. Entering Fig. 2 the steam consumption is found to be 4,500 lb. per hour and the steam rate 18.0 lb. per hp.-hr.

The exhaust steam from the hotwell pump is a small item, however. Assuming 80 per cent of the steam flow through the throttle or 240,000 lb. per hour of steam going to the condenser, the hotwell pump handles this amount, or 480 g.p.m. From Fig. 7 is found the steam consumption of 450 lb. per hour and the steam rate 30.0 lb. per hp.-hr.

The volume of air handled by each forced- and induced-draft fan at 300,000 lb. steam flow is obtained from Fig. 5, and the data for Columns 2 and 3, Table III, are obtained from Figs. 8 and 9.

To determine the load at which the circulating pump is to run, it is assumed that 80 per cent or 240,000 lb. of steam per hour passes into the condenser, and the available data inserted in the Table IV Circulating Pump. Cols. 2 and 3 derive data from Fig. 6, Col. 4 from Fig. 16, and Col. 5 is the corresponding absolute pressure.

Leaving Table IV for the time being, the data for Table V are filled in. Not knowing as yet the stage

pressures with bleeding, the non-bleed pressures, obtained from Fig. 13 and bowl pressure from Fig. 10 are used in Col. 1, the first approximation. Col. 2, except for open heater, is filled out by taking 10 deg. F. less than the temperature of saturation corresponding to the stage pressure. Col. 5 is the heat of the liquid corresponding to the stage pressure. By referring to the Molliere Diagram, the total heats of steam expanded adiabatically from bowl pressure and initial total heat (1,323) to the various stage pressures are listed in Col. 6. At the same time continue the expansion to the pressures listed in Col. 5 of Table IV, listing the resulting total heats in

TABLE V—FIRST HEAT BALANCE APPROXIMATION

	1	2	3	4	5	6	7	8
Stage	Pressure Lb. per Sq. In.	Temp. Deg. F.	Rise	Available B.T.U.	h	H	Ad. Drop	Act Drop
Bowl	330					1,323		
11th	108	323	36	923	304	1,212	111	96
13th	64	287	74	922	266	1,168	155	135
Open Heater		213	58					
18th	5.25	155	72	914	133	997	326	276
Exhaust	28.82 or .576	83	...	...	...	880	443	363

		Steam Bled	Remaining
11th Stage x =	$\frac{(300{,}000 + 3{,}900 + 15{,}550)\ 36}{926 + 36}$ =	11,500	288,500
13th Stage x =	$\frac{(288{,}500 + 3{,}900 + 15{,}550)\ 74}{922 + 74}$ =	22,900	265,600
18th Stage x =	$\frac{(265{,}600 + 3{,}900)\ 72}{914 + 72}$ =	19,700	245,900

Col. 6. Col. 7 (the adiabatic heat drop) in both these tables is obtained by subtracting Col. 6 from the initial total heat of 1,323. Col. 8 (the actual heat drop) in the first approximation, is obtained by multiplying items of Col. 7 by the proper stage efficiencies.

Additional energy is obtained through the expansion of main turbine steam to greater vacuum at the expense of additional circulating water, which means additional auxiliary steam. This energy is directly proportional to the adiabatic drop. The energy derived and the addi-

TABLE VI—SECOND APPROXIMATION

Stage	Pressure	Temp.	Rise	B.T.U.	h	H	Ad.	Act.
11th	104	321	42	920	301	1206	117	102
13th	56.5	279	75	922	258	1158	165	143
Open Heater	....	204	58	...	...	...	...	...
18th	4.25	146	63	911	125	985	338	287

		Bled	Remaining
11th Stage x =	$\frac{(300{,}000 + 3{,}900 + 15{,}550)\ 42}{920 + 42}$ =	14,000	286,000
13th Stage x =	$\frac{(286{,}000 + 3{,}900 + 15{,}550)\ 75}{922 + 75}$ =	23,000	263,000
18th Stage x =	$\frac{(263{,}000 + 3{,}900)\ 63}{911 + 63}$ =	17,300	245,700

tional auxiliary steam are the factors determining the economical vacuum. The saving in steam due to increasing the adiabatic heat drop by increasing the amount of circulating water from 30,000 to 40,000 g.p.m. and from 40,000 to 50,000 g.p.m. as shown in Col. 7 of Table IV, is $\frac{3}{443} \times 240{,}000 = 1{,}625$ lb. Comparing this saving with the steam consumption of the circulating pump turbine shows that 40,000 g.p.m. is obviously the most economical load for the circulating pump.

Table III may now be completed by inserting the data for the circulating pump, and also data are now available for filling in the exhaust conditions in Table V, which, except for Col. 2, is done in the same way as for the bleed-stage data. For Col. 2 the temperature of condensate entering the 18th stage heater is desired. The vacuum temperature for 28.82 in. Hg. is 84, and 3 deg. F. refrigeration of condensate is assumed. The gland sealing steam and the steam jet vacuum pump exhaust will raise the condensate 2 deg. F. (see Fig. 11 for 240,000 lb.), consequently the entering temperature is 84 — 3 + 2 = 83 deg. F.

Col. 4, Table III, is now obtained by referring items of Col. 3 to Fig. 14. Col. 5 is now filled in by multiplying items of Col. 2 by corresponding items of Col. 4.

The summation of Col. 2 gives us E for the equation for the quantity of steam bled. The summation of Col. 5 gives the total heat available for heating feed water in the open heater. Assuming 90 per cent, or 270,000 lb. of water enters the open heater, the temperature rise is 58 deg. F. This enables Cols. 2 and 3, Table V, of the first approximation to be completed. Col. 4, the heat available for heating the feed water, is tabulated as follows: Each item of Col. 4 equals 1,323 minus the corresponding item of Col. 5 minus the corresponding item of Col. 8. The tabulation for the first approximation is now complete, and the equation for determining the amount of bleed steam may be solved for each stage, bearing in mind the arrangement of apparatus, as shown in Fig. 1.

The remaining steam after 13th and 18th stages shows the first approximation of condensate entering the open

TABLE VII—THIRD APPROXIMATION

Stage	Pressure	Temp.	Rise	B.T.U.	h	H	Ad.	Act.
11th	103.5	320	42	921	301	1207	116	101
13th	56.0	278	73	922	257	1158	165	143
Open Heater	.....	205	59	...	...	...	...	...
18th	4.25	146	63	911	125	985	338	287

		Bled	Remaining
11th Stage x =	$\frac{(300{,}000 + 3{,}900 + 15{,}550)\ 42}{921 + 42}$ =	13,900	286,100
13th Stage x =	$\frac{(286{,}100 + 3{,}900 + 15{,}550)\ 73}{922 + 73}$ =	22,400	263,700
18th Stage x =	$\frac{(263{,}900 + 3{,}900)\ 63}{911 + 63}$ =	17,300	246,400

heater and steam entering the condenser to be sufficiently close. If this were not the case, it would be necessary merely to recalculate the temperature rise in the open heater and redetermine the vacuum before proceeding to the second approximation.

The stage pressures for the second approximation are now obtained from Fig. 13 and from the remaining steam for each stage (as determined in first approximation). This fills out Col. 1 and the tabulation is accomplished as before, expanding adiabatically to the new pressures.

Again solve equation 1 for each stage and recalculate the rise in the open heater.

Determining new stage pressures as before, the third approximation is next completed and the process repeated until these pressures are determined with sufficient accuracy. In fact, additional approximation may be made until the stage pressures are determined within the accuracy of such charts and steam tables as are available. When this is done, any attempt at further approximation will merely result in duplication.

Next proceed to calculate the load generated. The steam rates in pounds per kilowatt-hour of energy delivered to the shaft are obtained by dividing 3,415 by the actual heat drop in each case. The kilowatt output of the turbine is the sum of the kilowatts obtained by dividing the steam flows by the respective steam rates as indicated in Table VIII. The total load is then corrected for generator losses by reference to Fig. 12. The total pounds of steam divided by the generator output gives the plant water rate, $\frac{319{,}450}{28{,}000} = 11.42$ lb. per kw.-hr.

The B.t.u. supplied to a pound of steam by the boiler

is 1,323 — (320 — 32) = 1,035, and the B.t.u. rate is 1,035 × 11.42 = 11,820 B.t.u. per kw.-hr. Fig. 15 shows the unit steam rates and B.t.u. rates obtainable with the assumed conditions and circulating water temperature of 55 deg. F. These B.t.u. rates are of course

TABLE VIII—LOAD DETERMINATION

Stage	Actual Heat Drop	Steam Rate	Lb. Steam	K.W.
11th.....	101	33.8	13,900	411
13th.....	143	23.9	22,400	938
18th.....	287	11.8	17,300	1,470
Exhaust.....	363	9.44	246,400	26,100
			K.W. (Shaft)	28,91[illegible]
			K.W. (Bus)	28,000

in terms of steam, and it is necessary to divide by the boiler efficiency to obtain the B.t.u. in coal to produce one kilowatt-hour.

This heat balance shows what the station will do if all guarantees on equipment performance are fulfilled. It also gives the operating personnel a goal to strive for and of course valuable data for checking purposes.

In comparing bids on equipment to be purchased, it is seldom either necessary or desirable to calculate a complete heat balance, as a balance of operating economies against fixed charges of otherwise equally suitable apparatus can usually be made directly from points of difference in guarantees. Of course the probable hours of operation of the apparatus enters into the economies that may or may not justify the more expensive apparatus.

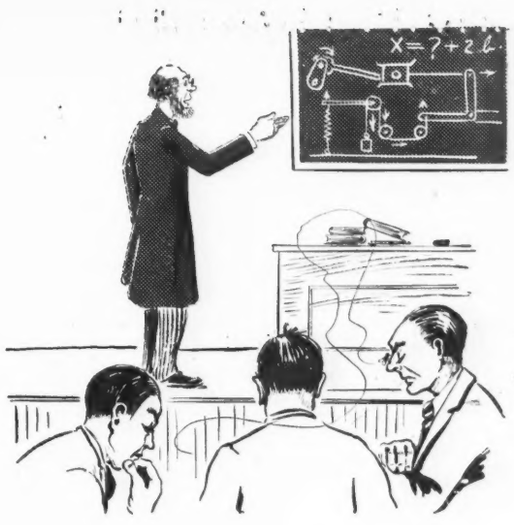
Surface Condenser Design—Correcting An Error

AN ERRONEOUS statement appeared on page 943 of the issue of *Power* for May 29, 1928, where a footnote said that the idea of disposing condenser tubes for tangential flow had not been applied to the surface condenser before Ginabat.

Attention has been called to the fact that this design, specifically covered by a patent issued Dec. 12, 1905, to John F. Grace, of the Worthington Pump and Machinery Corporation, has been embodied in fifty large condensers built by that company during the last 24 years.

On page 945 of the same issue there is shown a tube-sheet layout for condensers in the Gennevilliers plant in Paris, exemplifying the "folded" layout developed in this country and covered by a patent issued to T. C. McBride, consulting engineer of the same corporation, on Sept. 4, 1917. Several condensers have been built embodying this feature. See, for example, the paper on "Steam Condenser Practice and Performance," presented by F. J. Chatel, of The Detroit Edison Company, at the annual meeting of the A.S.M.E., December, 1926.

Power is glad to call attention to the fact that both these ideas originated in the minds of American engineers, and to disclaim any intention to state or imply otherwise.



WHAT DO YOU KNOW?

By L. H. Morrison

The answers are on page 30

Ques. 1—If the exhaust from a steam engine is to be used in process work, should the cylinder be lubricated by a straight mineral or by compounded oil?

Ques. 2—Does the viscosity of a cylinder oil have any influence on the results obtained from an oil?

Ques. 3—Why does a natural gas burn with a bluish flame, while oil shows an orange or red flame?

Ques. 4—What steam engine had the first poppet valve?

Ques. 5—Who invented the first self-propelled vehicle?

Ques. 6—What is the rating of the largest solid-injection Diesel engine?

Ques. 7—Why should the entire coils in a refrigerating evaporating system be kept filled with liquid ammonia?

Ques. 8—What inventor of water-tube boilers is most followed in the general layout of modern boilers?

Ques. 9—Into what service do most of the steam turbines built go?

Ques. 10—What is the minimum insulation resistance required by the American Institute of Electrical Engineers Standards for electrical machines at operating temperatures?

The Rise of a New Slave Power

In next week's issue M. D. E. Hite shows that man is in no danger of becoming the slave of the machine, as some self-styled philosophers claim True, he agrees slavery is a necessity of any civilization, but, so he declares, man is now replacing the human slavery of yesterday by the machine, to the cultural advantage of the masses.

Man is still the master.

Are Your ELEVATORS *Giving the Service That They Should?*

By F. A. Annett
"Power" Editorial Staff

Equitable Life Assurance Society's Building has 29 elevators

This article tells how practically 100 per cent elevator service is obtained by one large office building. Operating records kept, car schedules maintained, inspection and maintenance procedure and the costs of operation are given.

ELECTRIC-ELEVATOR operation has not been given the attention that it warrants. Even in this day, when so much consideration is being given to all kinds of cost analyses in production and plant operation, most elevators are operated by guess or with but little thought given to obtaining the best service from the available equipment. However, some of the more progressive building operators are beginning to give this problem serious consideration.

One of these buildings is that of the Equitable Life Assurance Society, New York City. In this building there are 26 passenger and one freight Gurney-General Electric elevators, serving 22 stories having an aggregate of 600,000 sq.ft. of rentable area for office use in which about 6,000 people work. There are also two hydraulic plunger-type elevators serving from the first floor to the second sub-basement. Of the elevators, 26, including the high-rise freight, are of the double-wrap gearless traction type, with a one to one roping and a car speed of 600 ft. per minute.

The main passenger elevators, 24 in number, are divided into four banks of six cars each, two banks on each side of the main lobby. These machines are operated by a modified form of variable-voltage, or Ward Leonard control. A complete description of these elevators appeared in *Power,* June 22, 1926, page 856.

Daily readings are taken of the power consumption, the car mileage and the number of stops for each elevator. These are recorded on a form shown in Fig. 3. The number of trips per mile is an established figure, obtained by dividing the feet per mile (5,280) by double the car rise in feet. From the record of car mileage and the number of stops the stops per mile are obtained. This figure, divided by the trips per mile, gives the stops per trip, which figure is used to judge the efficiency of the operators.

The stop counters are operated from the brake relays, so that every time the brake lifts it is counted as a stop. If the stops are found to be running above the average on a certain car, it is generally an indication that the operator is making a lot of false stops. On the other hand, if the stops per trip are found to be below the average, it is an indication that the operator is loafing.

When it is found that an operator is continually making an excessive number of stops per trip, he is transferred to another car that has been operating normally. The operator from the latter is put on the car that has been running with a high stop count. If he is unable to bring down the number of stops, it is concluded that the trouble may be in the equipment, and the matter is referred to the elevator mechanics to locate the cause. On the other hand, if it is found that the operator can reduce the number of stops to normal, the original operator will be assumed to be at fault and will be expected to bring his handling of the car up to standard.

This check applies mostly to new operators or when any question arises regarding the adjustment of the controller or brake. If a new operator is put to work and continues to make an excessive number of stops without showing any improvement, then it becomes a reason for dismissal. An operator that is found to be consistently making a low number of stops is checked up to ascertain the cause.

The figures for number of stops per car mile can be

further checked by the kilowatt-hours per car mile. The total kilowatt-hours per day divided by the total mileage gives the kilowatt-hours per car mile. For the high-rise cars that run express to the 14th floor and local from the 14th to 22nd the power consumption will vary from about 3.25 to 4.00 kw.-hr. per car mile. On an average about 3.75 kw.-hr. per car mile can be taken as a representative figure for the high-rise express passenger cars.

With a poor operator in the car the power consumption may exceed five kilowatt-hours per car mile, so that the effects of false stops are very evident. In checking over the records, it will be found that in practically every case an increase in the number of stops per car mile is accompanied by an increase in power consumption.

If a car stands idle for considerable periods, as when used by the watchman for night service, unless the motor-generator set is shut down it may result in a high power consumption per car mile even if the stops per car mile may be low. But even when the conditions are practically the same for the cars, the one making the greatest number of stops per mile will have the highest power consumption. In the cars the switch that controls the light also controls the motor-generator set. With this arrangement, when the operator leaves the car and turns off the light, by the same operation the motor-generator set is stopped.

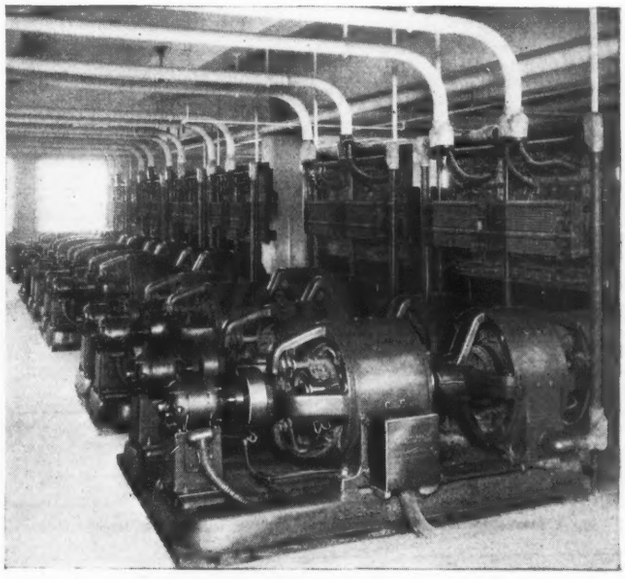
On the local cars the power consumption varies from about 4.25 to about 4.75 kw.-hr. per car mile, with an average of about 4.5 kw.-hr. per car mile.

The cars are used in various ways: for example, some of those running from the first to the 14th floors are used for express service during the rush hours only. Such cars may show a power consumption as low as 3.25 kw.-hr. per car mile. On the other hand, cars in night service may be idle the greater part of the time, and the motor-generator set may not always be shut down when the machine is idle. Under these conditions the power consumption may be 7 or 8 kw.-hr. per car mile. The high-rise freight elevator, which has a rheostatic type of control makes a total of from 23 to 25 car miles per day of 24-hr. service on a power consumption of about 6.75 kw.-hr. per car mile.

The schedule that has been adopted for the cars is to operate six of the high-rise cars express from the first to the 14th floors; and then local from the 14th to 22nd floors. From 8:30 to 9 a.m. only one car in this bank is on signal and no car goes any higher than is necessary to discharge its passengers. Five of the high-rise cars run local all day, from the first to the 22nd floors and one operates on special service, as a shuttle from the first floor to the second sub-basement. Six of the low-rise cars operate local from the first to the seventh floors, from 8 to 9:15, 11:45 to 1:15 and 3:45 to 4:15. During the rest of the day these cars are shut down. Six run express from the first to the eighth floors for the period 8 to 9 a.m. and then local from first to 14th floors for the rest of the day.

On the six high-rise cars running express to the 14th floor and local up to the 22nd floor, a 21-sec. schedule is maintained. Six low-rise cars, when running express to the eighth floor and local to the 14th, maintain a 17-sec. schedule.

About 40,000 passengers per day enter and leave the 24 passenger cars at the street floor. The highest peak occurs in the twenty minutes from 8:40 to 9, during which period 4,500 passengers enter the cars from the street floor. This is a rate of 13,500 an hour. For a



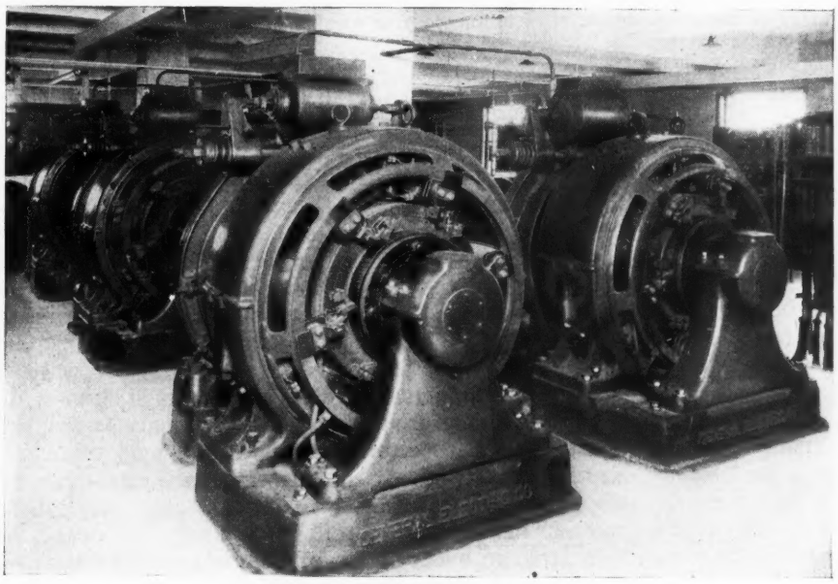


Fig. 1 (Left) — Bank of gearless passenger elevators. The machines are inspected each day. Outside of the daily inspection and cleaning there is practically no other maintenance required

Fig. 2 (Above) — Motor-generator sets for twelve of the 24 gearless variable-voltage passenger elevators. These machines are located on the main machine-room floor, which is well lighted so that every part of the equipment can be easily inspected

five-minute peak at about 8:50 the rate of passenger arrival is about 20 per cent higher than the average for the twenty-minute peak.

The elevator service has proved adequate to keep the street-floor corridors clear during all normal peak conditions. When the railway and subway schedules are disrupted at the same time, it may cause an abnormal peak for a few minutes, during which passengers may collect in the corridors. However, these occasions are very few and last only a few minutes when they do happen.

A count is made of the incoming passengers on the first Monday of each month, except when Monday falls on the first of the month. In such cases the count is taken on the second Monday. On the first day of each month many people come in to pay bills. This makes the traffic unusually heavy during the day, although it does not materially affect the peak loads, and therefore does not represent average conditions. The down count is taken on the Tuesday following the Monday count.

Maintenance of the elevator equipment, which also includes about 500 power-operated landing doors and the signal system, is in charge of the chief elevator mechanic, who has three assistants. During the four years these cars have been in service, these men have taken care of all repairs and the replacement of cables. They also take daily readings of the watt-hour meters, the mileage recorders and the stop counters. From these readings a daily report is made to the chief engineer, on a form, part of which is shown in Fig. 3.

No major repairs have been made. The chief work consists of keeping the equipment clean, making minor adjustments, taking care of the lubrication and replacing the cables. Every day the motor-room equipment is cleaned and inspected. The controllers being of the variable-voltage type, the contactors have to handle currents of small value only. This makes the wear light on these parts, so much so that only five contacts have been replaced in over four years' operation.

Compressed air is piped to all equipment and is used for blowing out the dust in remote places.

On the elevator machines the bearings are of the self-aligning babbitted-sleeve type with positive disk lubrication. Each bearing contains five gallons of oil, which is changed every two years. At this period the oil is all drained out and replaced by a fresh supply. No attempt is made to reclaim the old oil.

On the secondary sheaves of the elevator machines self-aligning roller bearings are used, and these are packed with grease every two years. The oil in the bearings of the motor-generator sets is drained and replaced at the same time it is done in the main machines.

Lubrication of the guide rails is supplied by wick-feed automatic lubricators, located in the penthouse, where they can be inspected daily by the mechanics when they are making their regular rounds. Lubrication of the governors is taken care of by the elevator mechanics on their regular inspections, by screwing down on the grease cups with which the governors are equipped. Grease-packed roller bearings are used on the governor sheave shafts, the governor-cable tension sheave shafts and on the compensating cable sheave shafts.

On the elevator machine motors maintenance consists of wiping the commutator and brushes occasionally to keep them clear. In addition to doing this on the motor-generator sets, a handstone is used when a commutator surface becomes slightly uneven.

Every three months the cables are thoroughly inspected. These inspections are made with the insurance company's and the city's inspectors in co-operation with the chief elevator mechanic. At this inspection the car is run to the top of the hoistway, then lowered about three feet at a time and all cables carefully inspected. An extension light from an outlet on top of the car provides illumina-

ELEVATOR RECORD

HIGH RISE

THE EQUITABLE LIFE ASSURANCE SOCIETY'S BUILDING

393 SEVENTH AVENUE, NEW YORK, N. Y.

DATE_____ 19__

ELEVATOR SERVICE	NO	TRAVEL	STOPS	HOURS IN SERVICE	CAR MILES METER READINGS START	CAR MILES METER READINGS STOP	MILES PER CAR	KILOWATT HOURS METER READINGS START	KILOWATT HOURS METER READINGS STOP	K. W. H. PER CAR	K. W. H. PER CAR MI	TRIPS PER CAR	REPAIRS	REMARKS
PASS'R.	1	368'—4"	2SB. TO 22											
PASS'R.	2	368'—4"	2SB. TO 22											
PASS'R.	3	368'—4"	2SB. TO 22											
GROUP 'D—2' TOTAL														
PASS'R.	5	321'—1"	1 TO 22											

CONDITION OF CABLES:

EXPLAIN REPAIRS & REMARKS:

SIGNED:

CHIEF ENGINEER

Fig. 3—Form on which record of elevator operation is kept

Since this form was adopted, three more columns have been added. One is for the total number of stops as obtained from the stop counter operated from the brake relay, in a second column are recorded the stops per mile, and in a third the stops per trip.

tion for this inspection. When a set of hoist cables are found with six wires broken in one strand per lay, they are replaced. If any cables are doubtful, but are thought not to be in a condition to be condemned, they are inspected about every two weeks until it is ascertained that they are going bad or are safe to operate to the next regular inspection. In this building conditions are such that it has not been found necessary to use any external lubrication on the cables.

About once a year the car safeties are tested by pulling the governor rope free of the carrier on the car and pulling the safety tail rope out until the safeties grip the rails. This is done from the top of the car so that all slack in the tail rope is taken up on the governor cable

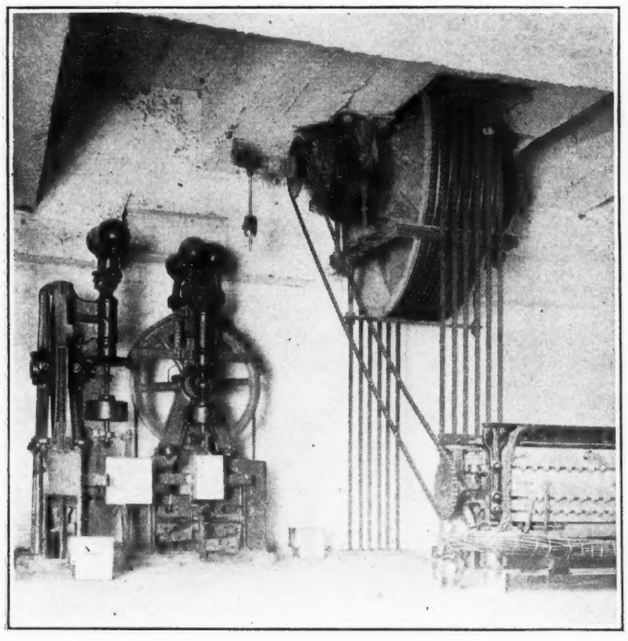


Fig. 4—Speed governors and signal apparatus are installed on the lower floor of the penthouse

On this floor are also the guide-rail lubricators, which can easily be inspected by the mechanics on their regular periods of inspection.

and will not foul when the cable is again wound on the safety drum.

All movable bearings on the safeties of these cars are made with bronze on steel, so that there is no danger of the safeties jamming. Plain vaseline has been found the best lubricant for the threaded shafts that screw into the safety-cable drums. It is less likely to collect dust and dirt, does not dry up and stays where it is put. The same kind of lubricant is used on the plungers that extend from the oil spring buffers.

The cost of operation has been low. The chief items of expense have been for power and mechanics' wages. For the years 1925, 1926 and 1927, the cost of mechanics' wages amounted to $27,796.09; for supplies, $1,666.55; for repairs, $9,573.44; and for current, $40,024.94. This gives a total operating cost of $79,061.02 for these four items. These figures do not include wages for the elevator operators and starters, but cover all other costs for maintaining the elevators, about 500 power-operated landing doors and the signal system.

In this period eighteen cars were reroped by the elevator mechanics. The cost of this work is included in the foregoing figures. These costs are for the 26 passenger and three freight elevators. During the three years' period the cars ran a total of 380,987 miles. This gives a cost per car-mile of 20.8 cents, of which 51 per cent is for power and 35 per cent for mechanics' wages. The repair item of cost is almost entirely for cables.

In this building, as in most successfully operated plants, eternal vigilance in the little things is the price of freedom from serious trouble. Cleanliness is a watchword, and this extends all the way from the motor room to the bottom of the hoistways, which are cleaned out every other day.

The author expresses his appreciation for the assistance rendered in the preparation of this article by G. N. Haines, real-estate supervisor; E. Serle, chief engineer and superintendent; R. Preyer, chief elevator mechanic of the Equitable Life Assurance Society Building.

Storing Armature and Field Coils

By C. B. Davis
Industrial Department,
General Electric Company

THERE is no factor more vital to the quality of service rendered by armature, stator or field coils than the manner in which they are stored. Properly wrapped or boxed coils, especially low-voltage types, can be carried as insurance against delays in production with comparatively little depreciation.

The first requisite is a warm, dry location, where the temperature is fairly uniform, free from fumes and metal dust or abrasives such as encountered in some manufacturing processes. The second is a good protective covering. This may be the original package in which the coils are received or, if the anticipated time of storage be long or the conditions not ideal, additional protection should be resorted to.

In the cases of random or mush-wound coils there is no better container than a tin box such as is used to pack crackers. A set of coils and insulation, carefully packed and sealed in one of these tins with the cover soldered on, will keep in perfect condition almost indefinitely. If properly labeled, it offers a safe, convenient package which requires only a few minutes with a blowtorch to expose the contents, leaving the container available for replacement of the coils and a further period of storage.

Where the coils are of the formed and taped variety, one of the most satisfactory methods of packing is to place one or more coils, according to the size and weight, in a paper bag with the leads projecting from the open end and then stacking these bags in a box, alternating the open and closed ends. The box, preferably a strong paper carton, can then be closed and sealed.

If the conditions are not ideal or the anticipated time of storage is long, a further protection may be given the coils in the form of a layer of tape (untreated cloth or varnished cambric) applied over the regular insulation and then the coil, so wrapped, dipped in hot paraffin. Extra large coils, especially field coils, may be wrapped with strips of burlap in the same manner as an automobile tire and then treated with a coat of hot paraffin.

If these precautions are taken, it will remove some of the exasperating production losses and delays sometimes caused by the failure of electrical equipment improperly cared for while in storage.

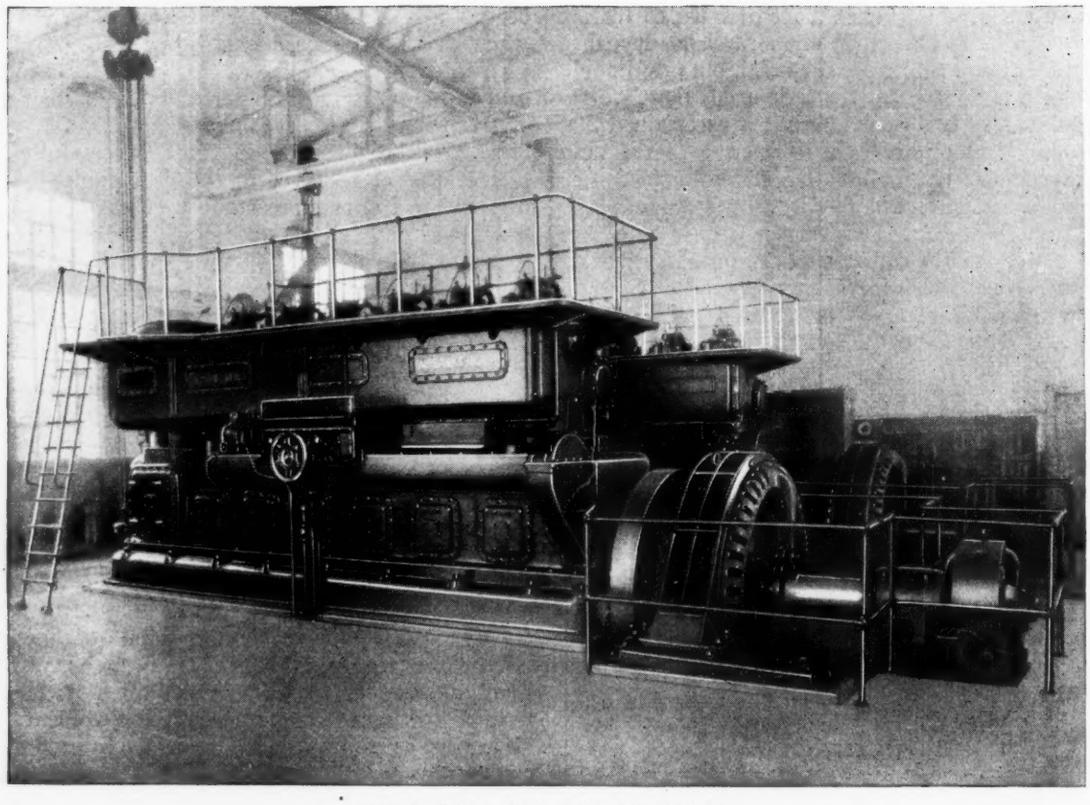


Fig. 1—View of the Falls City Diesels

Profitmaking with DIESELS

in Falls City, Nebraska

By G. Grow

THE criticism is often made against municipal light plants that they do not keep abreast of the time in regard to improvements in the generating units. Undoubtedly, this is true in many instances, for it is frequently difficult to convince a town's council that it is profitable to scrap machinery. However, the Falls City, Neb., municipal light plant has always been in the control of progressive managers, who have not hesitated to purchase new types of engines and boilers whenever the savings made by the new units would justify their purchase. After using steam engines of different types, the city finally installed Diesel engines and it has been found the savings will pay for the new machines in a short time.

Originally, this plant installed high-speed single-valve steam engines with direct-connected exciters. Steam was generated in horizontal return-tubular boilers. These operated satisfactorily for several years until the increased steam rate of the engines and the increased load made a change imperative. This led to the purchase of two cross-compound Corliss engines direct-connected to generators, one of which had a rating of 180 and the other 368 kilowatts.

In 1926 it became evident that additional power would have to be installed to meet the demand which would come on the plant during the following winter months, and owing to the high cost of generating current by steam as compared with the cost with the Diesel engine, the city decided to install engines of the latter type. A 720-hp. Fairbanks Morse two-stroke-cycle engine direct connected to a 600-kva. alternator was selected for the plant.

This first unit had to be installed without interfering with either of the steam units, since their peak load in the early fall ran as high as 500 kw. Consequently, it was installed in the boiler room.

As soon as the foundation and the exhaust conduit were completed, the wall dividing the engine room and the boiler room was moved back of the engine, and in this way the Diesel engine location was made a part of the engine room.

The unit was placed in service in November and oper-

ated in conjunction with the steam plant. The Diesel carried the load continuously and the steam engine was used only on evenings when the load exceeded the capacity of the oil engine.

The plant was operated in this way until June, 1927, when the 180-kw. steam unit was removed and a second 720-hp. Diesel unit installed, and placed in service in September. As soon as this second unit was in, the steam unit was discontinued, and since that time the plant has operated as an exclusively Diesel plant.

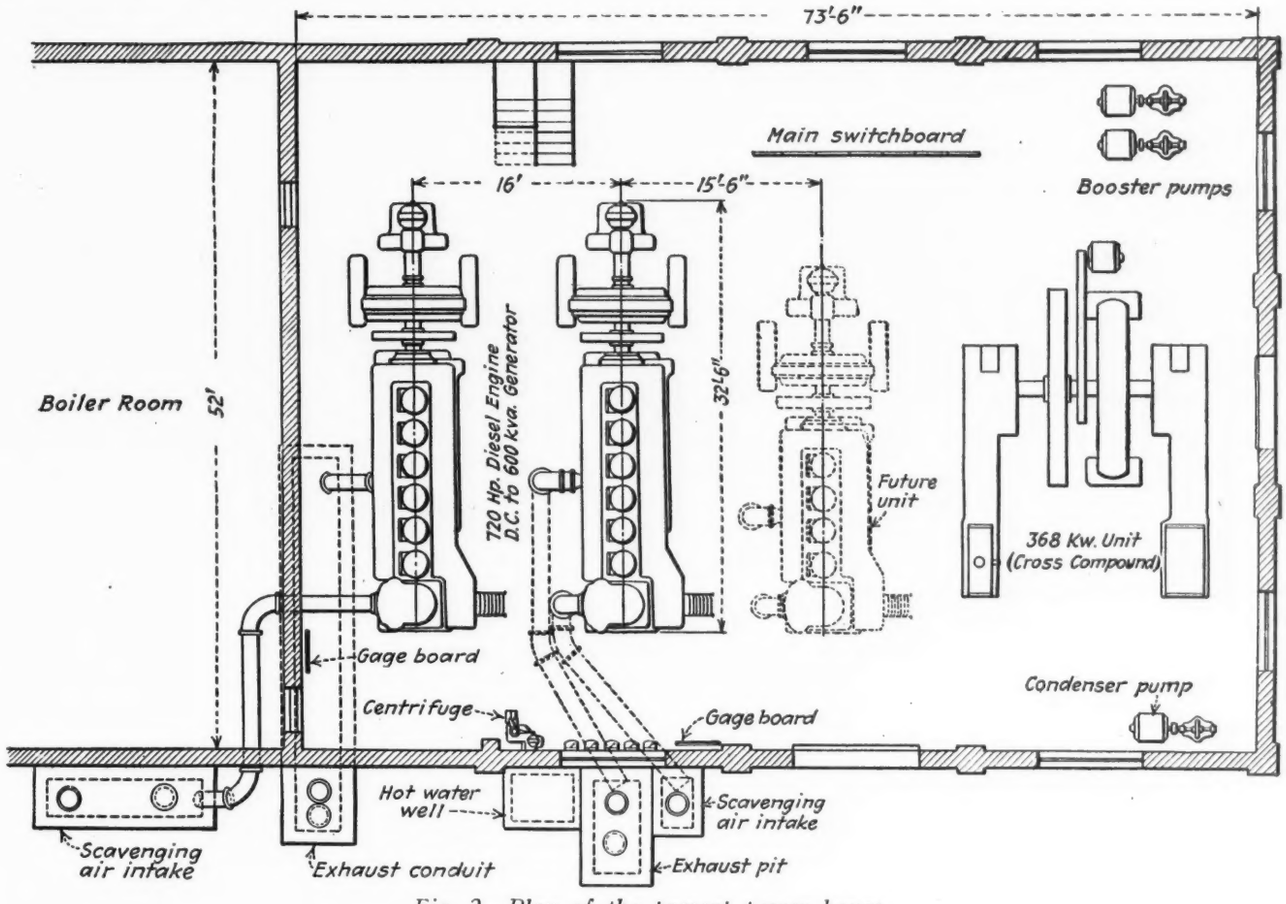


Fig. 2—Plan of the present power house

For the fiscal year ended April 30, 1926, which was the last year the plant was operated by steam, 1,865,490 kw.-hr. were generated. The coal and lubricating oil cost for that year amounted to $25,946.02, which made the cost 1.39c. per kw.-hr. for these two items alone. The boiler-room labor for the year amounted to $5,025, or a cost per kilowatt-hour of 0.27c., making the total cost for coal, lubricating oil and boiler-room labor 1.66c. per kilowatt-hour.

During the combined operation of steam and Diesel the latter was run continuously with the exception of regular inspections, which were made approximately every 20 days, the boiler fires being kept banked and steam used only on Saturday nights and when the Diesel was shut down for inspection.

The cost of coal for banking fires during this time amounted to $10.55 a day.

During the first three months of 1928, 542,510 kw.-hr. were generated at a cost for fuel and lubricating oil of $3,526.92, which gives a cost of 0.65c. per kw.-hr. It is conservatively estimated that for the year, 2,250,000 kw.-hr. will be generated. If this were generated with steam, the coal and lubricating costs for the year would be $37,350. This current at the present cost of 0.65c. per kw.-hr. will make a total for the year of $14,625, which subtracted from $37,350 will leave $22,725 as the net saving for the present year when generating this current by Diesel engines, against a cost of generating the same power by steam.

The exhaust arrangement on unit No. 1 consists of a pipe connection at 30 deg. from the center of the engine manifold to an exhaust conduit, which extends to the outside of the building. On the end of the exhaust conduit is a 20-in. stack 40 ft. high.

The air intake was first piped directly to the outside of the building, but on account of the noise it was later taken through a pit, the air being supplied to the pit from a 20-in. stack 30 ft. high, which is provided with a weather cap and screen.

On the second unit it was necessary to provide a different exhaust arrangement, since the auxiliaries for unit No. 1 in the basement were directly beneath the location of the exhaust conduit. The exhaust pipe on this unit was taken from the center of the exhaust manifold and run below the floor line and then to an exhaust pit outside of the building, and an exhaust stack 20 in. in diameter and 40 ft. high was placed on the exhaust pit. While these two exhaust arrangements vary quite materially, there is no noticeable difference in the operation of the engines or in the sound of the exhaust.

The air intake on unit No. 2 is run below the floor

and piped to a small pit just outside of the building, and on this pit is a stack 20 in. in diameter by 30 ft. high, which is identical with the stack on No. 1 unit.

The lubricating system for each unit is independent, the lubricating-oil circulating pumps not being interconnected. The centrifuge, however, serves both units, being piped so that the oil from either unit may be run through the centrifuge and returned to its respective system.

The cooling water is taken from a spray pond, which is fitted with twenty-four 1½-in. spray nozzles. The water from the spray pond is led to the basement of the power plant through a 10-in. main, and a 6-in. line leads the water to a 3-in. Fairbanks Morse centrifugal pump driven by a 10-hp. 1,800-r.p.m. motor. The open system is used and the cooling water discharges into a hotwell just outside the building. A suction line from the hotwell leads back into the basement to a 3-in. centrifugal pump direct-connected to a 7½-hp. 1,800-r.p.m. motor and a 4-in. pump direct-connected to a 10-hp. 1,800-r.p.m. motor. These pumps take the water from the hotwell and force it through the spray nozzles into the spray pond.

The makeup water for the cooling system is run through a Page-Jones water softener, and when the softener is not used for supplying makeup water it is connected with the discharge of the cold-water pump, and a portion of the water supplied by the cooling-water pump is forced through it and discharged into the hotwell. In this way the water in the cooling system is kept from becoming concentrated due to evaporation, and it has been possible to keep the hardness of the cooling water at about three grains.

The floor plan, Fig. 2, shows the location of the 720-hp. units and a proposed four-cylinder unit, together with the present 368-kw. steam unit, switchboard, and the booster pumps for the city water supply.

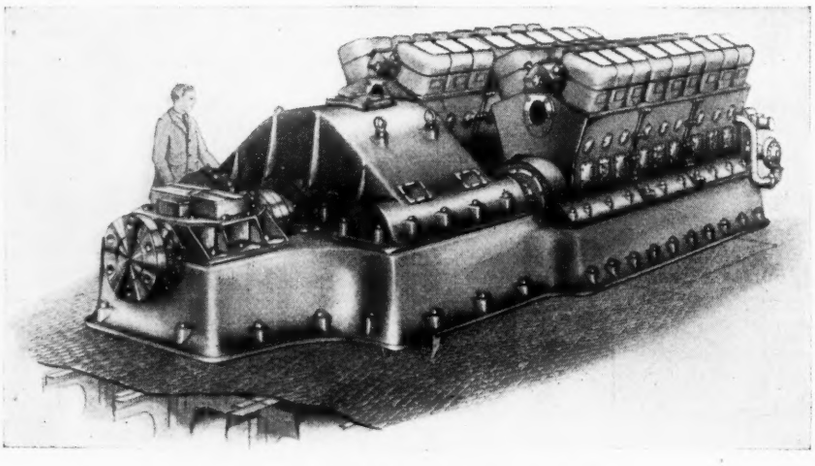
High-Speed Diesels of Large Capacity

THE argument is advanced in England that high-speed Diesel engines are superior for large motorships, as compared to slow-speed engines. The speed of the propeller of a direct-drive slow-speed engine is never the most efficient one. High-speed engines, on the other hand, could be geared to give the most favorable propeller speed.

The illustration shows a plan using two V-type Beardmore engines of a total capacity of 4,500 hp. Each engine is to have eighteen cylinders, 12-in. bore by 12-in. stroke, and to run at from 600 to 1,200 r.p.m.

The over-all dimensions of a set of engines and gearing of this type are: Length over-all, 34 ft. 6 in.; extreme breadth, 12 ft. 4 in.; and over-all height, 9 ft. 3 in. It will thus be seen that the space occupied compares favorably with that taken up by the equivalent steam turbines and reduction gearing.

Summarizing the possible savings and other benefits that would accrue from the adoption of these high-speed oil engines for such vessels as those sailing between English Channel ports, the actual voyage fuel consumed by the motorship would be half that of the existing steamer, that is, 4¼ tons as against 8½ tons for the round trip. With electrical deck machinery practically all the 4½ tons of oil used in port would be saved, making, at a conservative estimate, a total saving of 8¾ tons of oil per round trip. On the question of space occupied, practically the whole of the boiler-room space would be saved in the motorship, and this could be used for profit-earning purposes. As the cooling-water and lubricating-oil pumps of such an engine can be direct-driven, the motorship's engine room would be somewhat simpler than that of the steamer. Such items as bilge, ballast, sanitary and fuel-oil transfer pumps could be electrically driven, while the necessary compressed air for starting the main engines could be obtained most conveniently from a small air compressor arranged on the same bedplate with a 75-kw. generating set and driven by an oil engine.



A suggested 4,500-hp. high-speed Diesel

So far as machinery weight is concerned, 300 tons would be saved by adopting geared oil engines of the high-speed type, allowing 20 tons for cooling water, etc. This saving would probably be reflected in increased passenger and cargo capacity.

Are Municipal Light Plants Unprogressive?

. . . Have you read the story of the revamping of the Falls City, Neb., Municipal Light Plant, which begins on page 22?

. . . Do you agree with the author that municipal plants are as a whole unprogressive, or does the story disprove his opening statement.

. . . Or do you feel that the fact that 3,000 municipal light plants use oil engines proves conclusively that they are right up to the minute.

Letters from an Oil-Engine Operator—II

Some Thoughts on Fuel Oil

Dear Ed: I was disagreeably surprised to receive your letter stating that you are thinking of changing to a low-grade fuel for your Diesel engine. I am radically opposed to any such move, particularly on a solid-injection engine of the trunk-piston type. Experiments of this sort are not for you to conduct in your engine room, where dependability is of paramount importance. I have been through the mill and came out completely crushed in spirit.

I was operating a plant of 1,500 hp., and the boss got to thinking that the difference between $1.35 per barrel for common "bunker fuel" and $1.85 for a good grade of Diesel engine fuel would amount to the neat saving of $25 a day if we could do it, and "Barkus was willing." We tried it and everything appeared to be going lovely.

In the year of experimenting I had found the correct temperature at which to carry the heavy fuel, 14 deg. Bé., of Mexican origin, the correct fuel-valve lift, the correct time of injection, the correct injection-air pressure, and in fact the correct everything, so I thought. I had multiplied that $25 by 300 working days and the $7,500 saving looked good to me. It also seemed as if we could stand a few extra repairs if needed, and at the same time be ahead of the game.

The engines delivered the power, and although the exhaust was not quite so clear as it had been with the good fuel, I maintained that a little smoke would do no harm, for there were any number of solid-injection engines in the plants showing a little haze at the exhaust, and they gave no trouble.

In due course of time we found it necessary to give the cylinders a little more oil than usual in order to keep the pistons from dragging. We also found it necessary to clean the crankpits more often and change the oil at shorter intervals. The oil filters used to clog up quickly, and their cleaning required a bit of extra time. These were annoyances that we felt justified in putting up with, in view of the saving in the cost of fuel.

Shortly after we started to use the low-grade fuel, it came time for the annual overhaul and we found several rings stuck fast in the pistons that should have been free. The bearings were a little too slack, and the engines in general were not quite up to what they were the year before. Well, we thought, they were a little older and let it go at that.

Before another six months we had to shut down to draw a couple of pistons on account of gases blowing by. This did not discourage us. We found that we were having to stop and take up wristpin bearings occasionally and charged this to the engine's age.

In course of time we were taking every opportunity to shut down and pull a piston, take up on a bearing, clean the crankpits and overhaul the valves, and it seemed that we could not get caught up with our work. Although we would not admit it then, we were getting behind—the job was getting the best of us.

Finally, one of the engines began to smoke at the exhaust and we could not shut down to clean the flame plates and atomizers. A wristpin bearing melted out on us, and an investigation revealed that carbon residue had clogged up the oil passage through the piston to the bearing, for this was an old type of engine, not using pressure lubrication.

Reports of the numerous stops and delays went back to the office, and one day the superintendent came to me with a list of the involuntary stops in the plant since starting to use that fuel. I knew there had been too many of these, but I had no idea that there had been so many.

We got together right then and figured up the delay, the extra repairs, the increased lubricating oil consumption and the apparently excessive wear and tear on the engines, to say nothing of our nervous systems, and in place of saving $7,500 a year it looked as if we were out about $4,000.

Just how much the loser we were I cannot say, for there were items such as increased cylinder wear, damaged bearings, broken rings and worn ring grooves in the pistons, none of which made replacements immediately necessary, but their life had been shortened.

When we changed back to a good grade of fuel, we began to get our plant in shape again. Conditions were much pleasanter for all of us, and it was not long until everything was moving along normal lines.

I have been asked a number of times to state specifically what was wrong. The nearest correct reply I know is that combustion was wrong, that it was not complete and the residue stuck the rings, gummed up the cylinders, dripped into the crankcases and contaminated our lubricating oil. The oil simply got the best of the engines and crew.

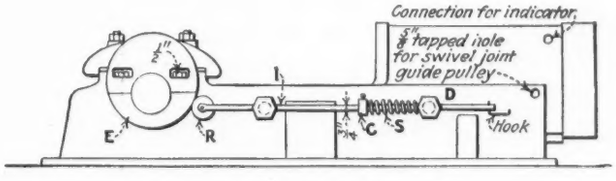
This is my experience, and I advise you to discourage any attempt to bring into your engine room a poor grade of fuel or lubricating oil. Yours for a clean job,

E. O. Leseid.

Indicator Rig for Oil Engines

By H. Weiland Los

THE majority of internal-combustion engines never are indicated, owing to the absence of a suitable rigging or a standard passage between cylinder head and indicator cock. In one instance it was necessary to remove the starting valves of a multi-cylinder engine in order to provide for an indicator connection.



The rig applied to an engine

One European builder is fitting permanent indicator riggings to all oil engines that leave the shop. An eccentric E is fastened to the crankshaft between the flywheel and the center bearing. The hollow indicator rod I is guided by two wrought-iron studs D screwed into the engine frame and pressed firmly against the eccentric by means of the spring S and collar C. A bayonet-catch or hook is fastened to the end of the rod.

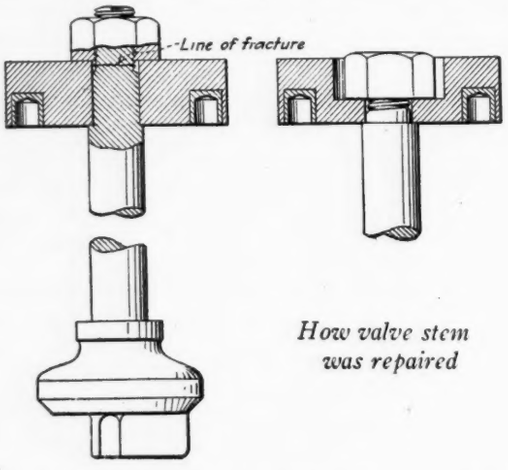
The arrangement is practically jointless, only a short indicator cord is required, and the principle may be equally well applied to vertical engines.

IDEAS FROM PRACTICAL MEN

For the exchange of practical information and ingenious expedients in operation and maintenance of plant and equipment

An Odd Break and a Quick Repair

TOWARD peak period, while the load was being distributed on the several machines, it was noticed that for some unaccountable reason one turbine would not take the limit of its load. An inspection, to learn what was wrong, disclosed the fact that the last valve



How valve stem was repaired

was not lifting, although it could not be seen where the stem was broken.

When the load had lightened sufficiently, the turbine was shut down and the valve taken out. The stem was found to be broken at the threaded part at the bottom of the nut, as shown in the view at the left of the illustration. No spares being on hand, a quick and effective repair was made as follows: The valve-stem guide plate was chucked in the lathe and recessed as shown. At the same time the thread on the valve stem was run down with the hand die. The reassembly is shown in the view at the right. As in the new form, there was less chance of a break occurring at this point than in the original, what was at first intended for a temporary repair, became a permanent one. S. M. QUINN.

Chicago, Ill.

Home-Made Metal Packing Gives Four Years' Service

IN A central-station power plant having six tandem engine-driven generators, considerable trouble had been experienced in keeping the six-inch piston-rods and the valve stems properly packed.

The engines were 22x30 in., slide-valve type, and used superheated steam at 165 lb. gage pressure. Several brands of packing had been tried out, none of which proved entirely satisfactory.

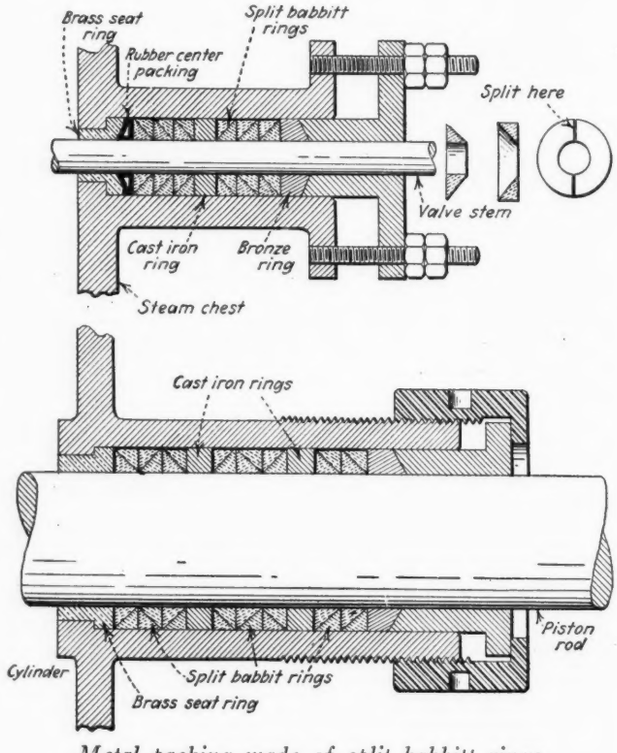
Saturday nights, when the load was heavy for a longer period of time, it was a common occurrence to have one or two piston rods and at least one valve stem blow out. As the packing had to be completely replaced after each blow, our bill for packing was high and the superintendent had complained frequently that proper care and workmanship had not been used in packing these engines.

The chief finally called a conference of the three watch engineers to discuss means of overcoming the trouble, with the result that a metal packing was tried out in place of the rubber-inserted and fabricated packing that was then in use. The packing was made at the plant from designs submitted by one of the engineers.

The piston-rod stuffing boxes on these engines were about 14 in. long and the valve stem boxes about 8 in. long, each fitted with a brass seat ring at the inner end.

First, a cast-iron mold was made in a local machine shop, to cast rings in three and two sections, both being tried out at the same time. These rings were made of good-grade babbitt metal. The rings for the pistons and valve stems were of the same shape; that is, three-cornered rings made so that when two rings of either four or six sections were placed together, it would make one square ring in cross-section.

Three complete rings were placed after the brass seat ring in each case on two of the engines, on the piston



Metal packing made of split babbitt rings

rods, and then a split ring of cast iron of the same thickness, then three more complete babbitt rings, another cast-iron ring, two more babbitt rings and a thrust ring next to the gland, also of cast iron.

When the engine was first started up with the new packing, the gland was screwed up tight with the spanner and then backed off loose and then screwed back finger-tight, only using the spanner to move the gland forward another half or quarter inch to line up with the lockpin which kept the gland from backing off.

A glass quart-size sight-feed oiler was placed above

the piston rods, using half cylinder and half light engine oil to lubricate the packing and rods. The engines were started up, and after a half hour of warming up they were put on the load.

At first the packing leaked more or less on account of being too cold, but after the engine had been in operation a few minutes under a full throttle, the packing expanded and tightened up, and only a small amount of adjustment was necessary to complete the job. In no case did the packing tighten up enough to score the rod. The valve stems were fitted in exactly the same manner, only in this case six complete babbitt rings were used and one cast-iron and one bronze ring, the bronze ring taking the gland.

A little more adjustment was necessary on these rods to make the packing tight. The two-section split babbitt rings proved better on the smaller rod than the three section rings. The hotter the rings got the better they held, and only on the occasion of a periodic shutdown of the superheaters did they leak.

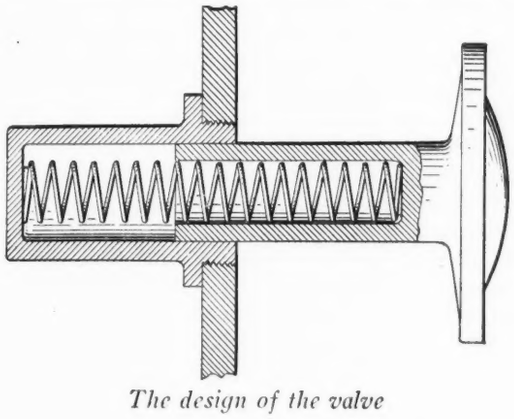
The illustration shows the arrangement and shape of these rings as they were used, and after a period of four years they are still in place without trouble and giving good service. One ring was replaced lately, as it was found to be broken, and no adjustment has since been necessary. The old-style packings cost the plant over a hundred dollars a month, so the saving due to the adoption of the babbitt packing can be readily reckoned.

It is now planned to renew the packing rings on the piston rods and the valve stems on one unit and test them for crystallization and wear. On one engine a rubber-center asbestos high-pressure ring will be used on the valve stems only, after the brass seat, to insure a good joint on account of the high temperature at this point.

Auburn, N. Y. W. L. JOHNSTON.

A Jammed Compressor Valve

ONE night a steam-driven vertical duplex ammonia compressor started to race, but the oiler got to the governor in time. The connecting rod of the horizontal Corliss cylinder was coupled to the same crankpin as



The design of the valve

was one of the compressor rods, and this brass began to get hot. The oil was poured on plentifully, but in a few minutes the pin was too hot to touch.

In the excitement the men did not notice that the frost was coming off one compressor cylinder, until a chunk of the frost hit the engineer.

Inspection showed the head end of the ammonia cylinders to be red hot. The machine was pumped out and the cover lifted. A discharge valve was found to be stuck open. This valve was guided to its seat by a large hollow cylindrical stem, wherein a stiff helical spring worked. The lift of this valve did not seem to be regulated by anything in particular.

The engine ordinarily turned 50 r.p.m., but when it raced the gas shot this valve up so high that it buckled the spring, and swelled the hollow stem out against the guide-nut hole so that the valve was held open.

This state of affairs allowed one side of the piston of that cylinder to be subject to condenser pressure all the time. As the crankpin brasses were none too plentifully supplied with oil groves, there was nothing left for them to do but run hot, as the oil could not get around the pin.

New York City. F. P. MACNIEL.

Precautions in Flameproof Switchgear

FLAMEPROOF switches are used extensively where the surrounding atmosphere is, or is likely to be, explosive. Their flameproof properties may be rendered nil by presence of dirt or the omission of some part such as a bolt. Through holes where they are drilled in the

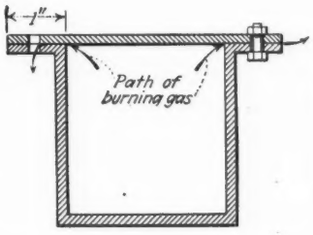


Fig. 1—Section of flameproof switch box with external flanges

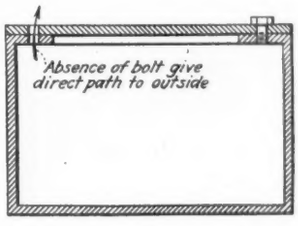


Fig. 2—Section of flameproof switch box with internal flanges

switch casing for the attachment of fittings or in the flanges for the cover bolts are a source of danger; normally these holes are closed by the bolts, but should one of these be omitted when reassembling after overhauling, a direct communication from the interior of the switch chamber to the atmosphere may be made.

In some types of flameproof switches the flanges are rough-machined and their width made one inch or over. When the cover is placed in position and bolted down, the flame from any internal explosion is cooled and extinguished before it reaches the outside surface. This prevents the ignition of combustible material outside the switch case. With an external flange and through holes, the omission of a bolt will reduce the flange width to that of the distance from the inside of the casing to the edge of the inside of the bolt hole. This distance may be less than the minimum of one inch of flange width allowed to extinguish the flame. The path of the burning gas is indicated in Fig. 1. With all the bolts in place the path of the burning gas is as at the right in the figure, while with one bolt removed it is as at the left.

With internal flanges the results are more serious than with external flanges, since the omission of a bolt gives a direct path from the switch chamber to the atmosphere through the bolt hole, as indicated in Fig. 2. On more than one occasion the omission of the bolts from switch casings has resulted in accidents. Where an internal flange exists with through bolts, these holes should be covered on the inside by fixing a small metal plate over the holes.

W. E. WARNER.

Brentford, England.

COMMENTS FROM READERS

In which those who agree and those who disagree, with either authors or editors, are afforded an opportunity to express their views

The "What Do You Know" Editor Did Not Tell All

REFERRING to Question 6 of the "What Do You Know Column," in *Power,* June 12, regarding fine threads on oil-engine connecting-rod bolts, the editor did not tell the whole story.

In addition to less force being required to produce a given pressure between the bearing parts, the fine-thread bolt has about 15 to 20 per cent more sectional area at the root of the thread, and is consequently that much stronger.

Moreover, owing to the smaller helix angle, the nuts on the fine-thread bolts are less likely to work loose.

Frankfort, Pa. WALTER S. GRISCOM.

* * * *

Heat Interchangers

REFERRING to the article on heat interchangers in the May 22 issue, it might interest some readers to know that the type of heat exchanger or evaporator referred to has been in use in this country for a number of years.

The company with which I am connected installed a plant of this character in the Cecil Plant of the Allegheny County Steam Heating Company in Pittsburgh in 1924. This plant had a capacity of 100,000 lb. per hour, using 100-lb. steam with distilled vapor at 15 lb. pressure for steam-heating service. Last year we placed in operation for the Toledo Furnace Company a plant of 100,000 lb. per hour capacity, using high-pressure steam of 275 lb. pressure to distill vapor at 150 lb. pressure for industrial power and service demands. At the present time we have under construction two such plants using 400 lb. steam pressure for distilling 150 lb. vapor.

There are a number of other plants of this type which have been installed by the Foster-Wheeler and the Griscom Russell Companies of which I have no personal knowledge as to details.

C. F. DIXON, Power Engineer,
New York City. Dwight P. Robinson & Company.

* * * *

Plant Presentability

UPON reading the Editor's Foreword in the April 3 issue on "Plant Presentability," I was inspired by the thought that here was a man after my own heart. But where and how to find that appreciative management —there lies my difficulty.

Yes, I have those ferns and flower boxes, although the rugs are strips of rubber matting. Practically every item toward the appearance and improvement in the plant, with the exception of half a barrel of paint, had to be obtained by hook or crook and camouflaged requisitions.

From the filthiest, most unhealthy plant you were ever in to a shiny spotless condition of the main office has been a long, hard, one-man job, but the satisfaction of accomplishing this feat has more than compensated for the lack of interest on the part of the company.

To cite minor instances, finding the idea of a single-sweeper standard vacuum system was a dead issue, I built an ejector system out of an old soot cleaner and second-hand 2½-in. pipe. I connected it into one of the cyclones, using 100-lb. air on the ejector and got 14 in. vacuum. But that's all the good it did me, for the management wouldn't buy a cleaning hose even though I had made tools for it. Not having a place to wash up in, I found an old iron sink, cleaned it up, put in a drain and was on the point of installing it, when I was informed there was no need of it, as a washroom was in one of the other buildings. But I waited an opportunity and later rigged up a disappearing sink.

Janitor! That individual would hold an exalted position here. The operator is general mechanic, electrician, machinist, steamfitter, tinsmith, mason, painter, yard man and janitor, in spare moments.

The duties of operation and maintenance for a one-man eleven-hour shift cover coal-preparation plant, pulverizing plant and all motors in the boiler house.

I might add that the plant was started in the latter part of 1926 and to date there has been only a period of twenty minutes in which coal was lost under the boilers, but that is a thing of the past now and we are operating under the guaranteed output a great deal of the time.

Boston, Mass. W. E. SIMPSON.

* * * *

Hazards in Coal and Ash Handling

THE letter in the May 1 issue by K. Rankin, calling attention to the hazards in coal and ash handling, is timely. Undoubtedly, too little consideration is given this most important factor in determining what is the proper equipment to employ when designing a power plant.

Obviously, it is desirable to select equipment that requires least man-attention. Machinery that does not frequently require an attendant to go into dangerous places will always be better from a safety point of view than accepting such risks as unavoidable and trying to minimize them by safety railings, warning signals, etc. Such machinery will be made up of the fewest number of wearing parts and will have the fewest points requiring lubrication. From this viewpoint, in my opinion, cable-driven equipment, such as automatic skip hoists, cable cars and cable drag scrapers, will be less dangerous than multiple-part machinery such as bucket elevators and other chain machinery. Cables are strong and reliable for severe continuous duty and have the further advantage of giving warning by fraying or "cat-tailing" before failure. Regular cable inspections should eliminate the possibility of break-downs for the class of equipment named. Also, cable-driven equipment is made up of the smallest possible number of parts, these parts being proportionately bigger and heavier and requiring renewal less frequently. Frequent repairs, hastily made, are the cause of many accidents.

Dust and poisonous fumes from ashes have eliminated some types of ash-handling equipment from serious consideration by thoughtful engineers. One man's life or

one man's health is more important than saving small amounts on capital outlay, especially when such savings materially increase operating costs. Modern boiler settings are placed sufficiently high above grade to permit a basement for ash removal rather than a tunnel. Ash hoppers of adequate storage capacity are fitted with quenchers that spray sufficient water on the ash to obviate dust and fumes. Side-opening, gravity-discharge water-collecting ash gates are used on these hoppers. Under these conditions there is no danger to attendant. The additional space made available by the use of a basement affords room for fans and other equipment. The damp (not wet) ash may be stored in an overhead bunker for ultimate delivery by gravity without poking or barring, eliminating the dangers referred to in Mr. Rankin's letter. Freezing may be avoided by locating the ash bunker inside of the boiler room or, if outside, by providing steam coils for thawing out the bottom when frozen. It should be remembered, however, that thoroughly wet fine ash will "cement" in any bunker, no matter how steep its sides. Consequently, quenching water should be used only in sufficient amounts to allay the dust.

The "ounce of prevention" provided by a proper and intelligent selection of coal- and ash-handling equipment will prevent accidents and impairment of health by removing the conditions that make them possible.

Chicago, Ill. C. C. PLUMMER.

* * * *

Cleaning the Fire Side of Boiler Tubes

WHILE reading the article on "Cleaning the Fire Side of Boiler Tubes," by H. A. Seiller, U.S.N., and the editorial in the April 17 issue, I thought it would be of interest to some of the readers of *Power* to know it is not an unusual occurrence to clean the fire surfaces of water-tube boilers hydraulically. This system is used quite extensively where the fuel burned is what oil refineries call acid sludge or a heavy grade of Mexican or Venezuela fuel oil, and the higher the sulphur content and the more acid left in the residuum after the "cracking process" in the refinery, the harder it is to keep the fire surfaces clean.

In my experience as boiler inspector I have examined water-tube boilers that had the fire surfaces of the boiler and superheater washed as regularly as the internal surfaces, and in most cases the external surfaces were the cleaner when the job was completed.

I have seen charts from recording thermometers that showed a drop of flue-gas temperature of 200 deg., and a 125- to 150-deg. drop is common occurrence owing to washing the tubes.

I do not believe it necessary or practical in stationary practice to try to use a drip pan or curtain as described in the article, for if the work is done with the brickwork and water at proper temperature, there is practically no water absorbed by the brickwork in the short time required for the job, and, when completed, the heat of the brickwork will quickly dry the surfaces without a drying fire. From my observations the best temperature for the water and the brickwork is 150 to 170 degrees.

The nozzle commonly used is of the adjustable type similar to those used on garden hose, so the spray or stream can be varied to meet the surface requirements.

On a 6,000-sq.ft. boiler with a superheater above the tubes, I have witnessed the cleaning of superheater and tubes in slightly over one hour.

I inspect water-tube boilers in southern Texas that have had their external surfaces regularly cleaned for over three years, and a power plant in Mexico that has used this method for ten years, and the setting and baffle repairs have not been as great as before and the boiler and furnace efficiency has been increased.

I would not advise any engineer to discard the use of soot blowers, but I think most of us know of cases where, as generally operated, they have left sufficient deposit on the tubes to increase the flue-gas temperature materially. When the external surfaces are cleaned hydraulically, they are nearly as clean as when new, and if the work is done at the proper temperatures, I have yet to find any appreciable deterioration to brickwork or baffles. H. E. FLOWERS.

Houston, Tex.

* * * *

Combustion Control Formulas

MR. RANDALL'S criticism in the May 15 issue of *Power*, of the equicalorific properties of the pound-carbon fuel unit indicates that he judges it from the viewpoint of the expert rather than from that of the practical operating engineer. The purport and practical significance of the pound-carbon fuel unit and the formulas based thereon, rest on their usefulness in continuous application to the economic control of boiler operation. They are intended to aid the practical operating engineer in keeping tabs on the performance of his boilers, not the scientific expert in making elaborate boiler tests.

One of the principal difficulties of the operating engineer of the average power plant is to get true analyses and correct heating values of the coal he is using. This difficulty is overcome by the pound-carbon fuel unit, which is practically equicalorific for each class of fuel. This was demonstrated by several hundred analyses and determinations of the heating values, of samples taken, by the Bureau of Mines, directly from the face of the coal veins in representative mines of all the more important coal fields. The table showing this is not given in the abbreviated Article II, in the Dec. 20, 1927, issue of *Power*.

I do not claim that the heating value of the pound-carbon fuel unit as given in Article II is more nearly correct than it is possible to determine by the most modern and approved methods of sampling and analysis; but I do contend that the standard heating value of the pound-carbon unit more nearly represents the average heating value of the coal used in 90 per cent of the power plants, than the heating value ascertainable by the engineer responsible for its economic consumption. It is safe to say that the standard pound-carbon heating value is more nearly correct than the heating value used in the majority of boiler tests, including many made by experts.

The difficulties in securing a true average sample of coal and from it getting its true heating value was demonstrated by Tables I and II (Article II) taken from the analyses of the coal used in the Delray boiler tests. These tests were chosen for this and other purposes because they are the most widely known, most celebrated and most authoritative set of boiler tests ever made. The fact that these tests were made seventeen years ago and the fact that the art of sampling has since then been elaborated and improved do not reduce the difficulties that beset the operating engineer of the average power plant.

To show the improvement made in the art of sampling coal, Mr. Randall calls attention to a record series "of

high-grade tests made after ten years of experience on the same boilers at Detroit." He illustrates this improvement by giving the results of triplicate samplings for each of four tests. In Table I he shows that the heating values of samples *D* and *P* vary from sample *S* as follows:

TABLE I—PER CENT VARIATION IN HEATING VALUES

	No. of Test			
	4	9	14	24
Sample *D*	1.23	0.61	0.39	3.01
Sample *P*	1.77	1.01	1.14	0.47

In Table II he gives the ultimate analyses of each of the three samplings for the four tests and the pound-carbon heating values (calculated from the analyses) which vary from the standard heating value 17,900 B.t.u. as follows:

TABLE II—PER CENT VARIATION FROM STANDARD HEATING VALUE

Samples	*D*	*S*	*P*	Average
Test No. 4	2.11	0.11	1.20	1.14
Test No. 9	1.12	0.78	0.11	0.67
Test No. 14	1.00	2.15	0.68	1.28
Test No. 24	1.20	4.46	1.56	2.41
Average of average variations				1.40

In presenting this comparison Mr. Randall does not do justice to his case. Instead of comparing the heating values of the *D* and *P* with that of the *S* samples the average heating value of all three samples of each test should be compared with their respective average heating value. Making the calculation necessary, I find that the heating value of the individual samples of the respective test compare with their averages as in Table III.

TABLE III—PER CENT VARIATIONS FROM AVERAGES

Samples	*D*	*S*	*P*	Average
Test No. 4	0.30	0.95	0.84	0.70
Test No. 9	0.75	0.14	0.89	0.59
Test No. 14	0.66	0.25	0.90	0.60
Test No. 24	1.83	1.15	0.68	1.22

This comparison shows how the heating values of the respective samples vary from their average heating values, which is presumably the nearest attainable approach to the true heating value of the coal sampled. Thus, while the heating values derived from samples *D* vary from 0.39 per cent to 3.01 per cent, from samples *S*, they vary only from 0.30 to 1.83 per cent from the average heating value of all the samples. The average variation of the three samples from the approximately true heating value of the coal used in test No. 24 is 1.22 per cent. On the other hand, Mr. Randall has shown that the approximately true heating value of the pound-carbon unit as determined from the *S* samplings varies from 0.11 to 4.46 per cent from the standard 17,900 B.t.u. for bituminous coal. The greatest average variation from the standard of the average of the three samplings is 2.41 per cent. This would be the error in heating value in test No. 24 if the standard 17,900 had been employed. In tests No. 4, 9 and 14 the errors would have been respectively 1.14, 0.67 and 1.28 per cent, or an average for the four tests of 1.40 per cent. The averages then compare as in Table IV.

TABLE IV—COMPARISON OF PER CENT VARIATIONS

Tests No.	4	9	14	24
Average variation from standard	1.14	0.67	1.28	2.41
Average variation of single samples from average of triple samples	0.70	0.59	0.60	1.22
Difference in favor of sampling and analyses	0.44	0.08	0.68	1.19
Average of differences	0.60	....	....	....

Thus we see that if the standard pound-carbon heating value of the coal had been adopted, the probable error would have varied from 0.67 per cent in test No. 9 to 2.41 per cent in test No. 24, whereas if one sampling had been depended upon, the probable error would have varied from 0.59 to 1.22 per cent. If duplicate samples are employed, this will be reduced. Triplicate samplings will decrease it still further, provided the necessary experience, skill and science are exercised in securing and analyzing them. Now I want to ask Mr. Randall in what percentage of boiler tests are the heating values derived from triplicate or even duplicate samplings scientifically secured and treated?

I will readily admit that taking large samples with the greatest care and ripe judgment, reducing them according to the most approved method and analyzed by a competent chemist, will yield heating values much closer than the pound-carbon standard. But, as previously stated, the pound-carbon fuel unit and the formulas based on it were developed for the benefit of the operating engineers who wish to exercise intelligent economic control over the operation of their boilers. The great practical advantage of pound-carbon fuel unit is that heating values, as well as the simple formulas for determining the heat losses, are quite independent of the variation in the impurities contained in the fuel and the consequent variation in its pound heating value.

E. A. UEHLING.

Milwaukee, Wis.

ANSWERS to "What Do You Know"

The questions are on page 17

Ans. 1—The straight mineral oil can be removed more readily from the steam.

Ans. 2—High-viscosity oils withstand the rubbing action of the piston better than low-viscosity oils. High-viscosity oils are less susceptible to scouring by steam and moisture. Oils of low volatility will remain on the cylinder wall for a greater length of time after the engine is shut down than those of high volatility, a great advantage when the engine is operating at irregular intervals. Oils of low volatility are more economical in forming a film than those of high volatility.

Ans. 3—Gases usually burn with a blue color since gases do not glow to any extent. The orange color in the oil flame is due to the burning of the carbon solids in the hydrocarbon content of the oil.

Ans. 4—The old Cornish steam engines of Watt's time used poppet valves.

Ans. 5—Oliver Evans, of Philadelphia, Pa., in 1804 built a vessel that would move on both land and water.

Ans. 6—A 11,000-hp. solid-injection engine has been built in Germany.

Ans. 7—The portion of the coil left dry can only serve to superheat the gas leaving the liquid. Consequently, to give the maximum heat exchange, the coil should be kept as full of liquid as is possible without the compressor pulling over liquid.

Ans. 8—Bell, who invented the inclined-tube multi-drum boiler, has the largest following.

Ans. 9—Most of the turbines built are under five horsepower capacity and are used to drive draft blowers.

Ans. 10—The insulation resistance at operating temperatures should be not less than that given by the formula,

$$\text{Insulation resistance in megohms} = \frac{\textit{voltage at terminals}}{\textit{rating in kva.} + 1{,}000}$$

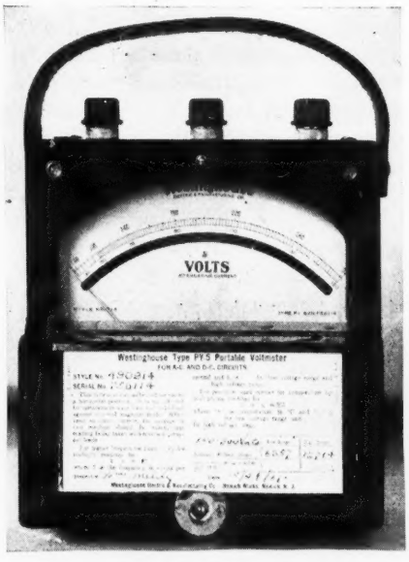
For example the insulation resistance of a 2,000-kva. 2,300-volt alternator should not be less than $2{,}300 \div (2{,}000 + 1{,}000) = 0.766$ megohms, or 766,000 ohms.

PLANT EQUIPMENT NEWS

New and improved equipment in power and industrial plant fields, and new applications of existing equipment

New Westinghouse Portable Alternating-Current Instruments

THE Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has recently brought out a new line of portable alternating-current instruments designated as type PY5. They are of the direct-reading type and are applicable for general testing and laboratory work where high accuracy is required.



Type PY5 portable voltmeter

The voltmeters and single-phase wattmeters are of the electrodynometer type. The ammeters are of the moving iron type using vanes of non-residual metal. All instruments are shielded and are damped by an improved design of air damper, making possible accurate measurements on fluctuating loads.

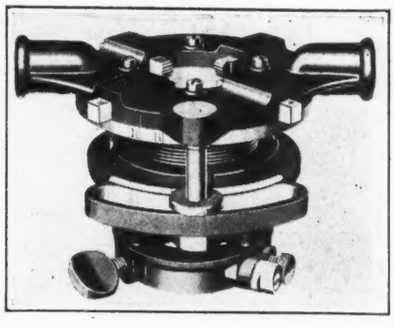
The ammeters have a double range which can be changed while the meter is in use by a series-parallel switch mounted in the case. They may be used on circuits up to 500 cycles and also on direct current with but slight reduction in accuracy.

The voltmeters can be used without appreciable error on direct current and on alternating current up to 133 cycles. They are provided with a push button for closing the circuit. This can be locked in the closed position when using the instrument for continuous service.

The single-phase wattmeters may be used on circuits up to 400 cycles without requiring correction for phase displacement. The current circuits are double range with series-parallel arrangement of coils, and are controlled by a switch inside the instrument operated by a knob in a recess in the case. Voltage ranges are changed by changing the terminal connections. The voltage circuit contains a push-button switch which may be locked in the closed position.

New Beaver Pipe-Threading Machine

TWO new designs of the Beaver die stock brought out recently by the Borden Company, Warren, Ohio, include improvements that give greater simplicity and easier working with reduced weight. In these new tools one set of dies is quickly set to thread 1-in., 1¼-, 1½- or 2 in. without changing the dies. The dies cannot become lost or mislaid because they are always in the tool, and they are quickly adjusted to thread under or over standard size without affecting the length of the thread. No special dies are needed for brass pipe. The die heads and threaded barrel are two separate parts, so that for repairs only one part need be bought.



Improved threading machine with integral adjustable dies

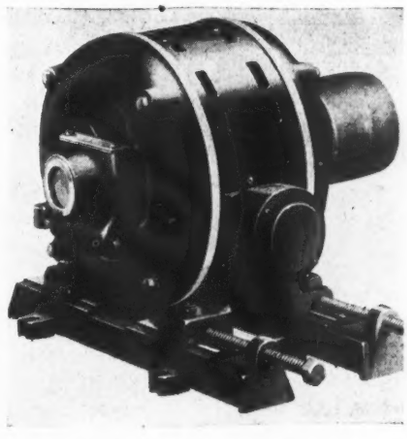
In the new work holder, or pipe-gripping device which centers the pipe, two knurled screws hold the pipe, leaving only the thumbscrew to be tightened after the die stock is placed on the pipe.

Condenser Starting Single-Phase Motor

THERE has recently been developed and placed on the market a line of single-phase motors, by the Howell Electric Motors Company, Howell, Mich. These motors are of the condenser type and in construction are similar to the squirrel-cage polyphase type. In the stator are two groups of windings as in a two-phase motor. The rotor is of the simple squirrel-cage type, without any brushes or commutator. The two stator windings are left in circuit continuously as long as the motor is connected to the line. One of them is not cut out of circuit after the motor comes up to speed as is done with the split-phase type.

Starting is obtained by a static condenser connected permanently across the windings. This condenser acts during starting to give the necessary torque and improves the power factor of the motor when it is in operation. The condenser is contained in a sheet-steel box and can be mounted in any convenient position near the motor.

For motors requiring a higher torque than standard, two sets of condensers in one box are used. One of these condensers, known as the starting unit, is in service only during the starting period and is automatically cut out when the motor comes up to nearly full speed. The starting torque of these motors can be made



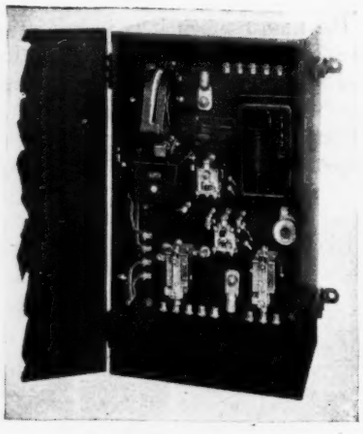
Single-phase motor without its condenser unit

comparable with that of the polyphase-type.

These motors are built for a range of speed from 3,600 to 300 r.p.m. and in size up to 30 hp. They are particularly adapted to slow speeds, since the condensers correct the inherently low power factor of the slow-speed type machines. They are built with either sleeve or tapered roller bearings and can be obtained in either the vertical-shaft or the horizontal-shaft type.

Control for Automatic Arc Welding Eliminates Arc Crater

THE General Electric Company, Schenectady, N. Y., announces an improvement in the control equipment used with its automatic arc welding heads, by means of which the feed of electrode wire is stopped a short time before shutting off the welding current at the end of the weld. This serves two purposes: First, it clears the electrode from the weld; second, it fills in the crater which is inevitably left at the end of the weld when the arc is cut off short.



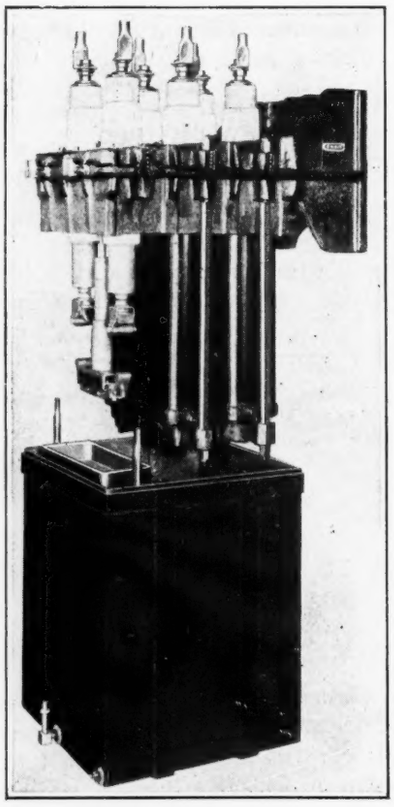
Welder control panel

The control panel illustrated is controlled by a "Start-Stop" push-button station. Mounted on the panel are a line contactor of suitable size for the welding current, an arc voltage regulating relay, and relays for controlling the travel motor and for clearing the electrode from the weld. The rheostats for controlling the arc voltage and the speed of the electrode motor are mounted on the outside of the sheet-metal inclosing case. A small meter panel is used for indicating the arc voltage and welding current.

Oil Circuit Breaker Has Double-Tank Construction

AN OIL circuit breaker of relatively high interrupting capacity and comparatively small over-all dimensions, known as the type D-131, has been placed on the market by the Condit Electrical Manufacturing Corporation. In the development of this oil circuit breaker there have been retained time-proved features of the type D-21, together with certain additional features which recent research and field practice have shown to be sound.

The frame is of heavy and sturdy construction to afford rigidity—such construction is desirable in a circuit breaker frame to assure stability, proper functioning of the mechanism.



Circuit breaker with the outer tank and one of the inner oil tanks lowered

A double tank construction is used. An individual inner tank per pole is furnished, which is overlapped by the frame several inches. These inner tanks are supported by a heavily ribbed steel cradle, which is in turn secured by rods suspended on springs set in the frame. This arrangement provides an energy-absorption feature for taking care of the mechanical shock incidental to rupturing a heavy short circuit. A large outer, or spill, tank is also provided, which fits around the other tanks and is supported from the frame.

The main current-carrying contacts are inverted laminated brushes of special design which will withstand high inrush currents. Heavy arcing contacts are used, whose large thermal absorption capacity materially reduces arcing on interruption. Until the brushes have safely parted, the arcing contacts remain firmly closed.

The new oil circuit breakers are built for 400, 600, 800 and 1,200 amperes at 15,000 volts and 1,600 amperes at 7,500 volts, with an estimated interrupting capacity of 7,000 amperes at 15,000 volts. They are furnished two, three and four poles, single-throw, manually or electrically operated.

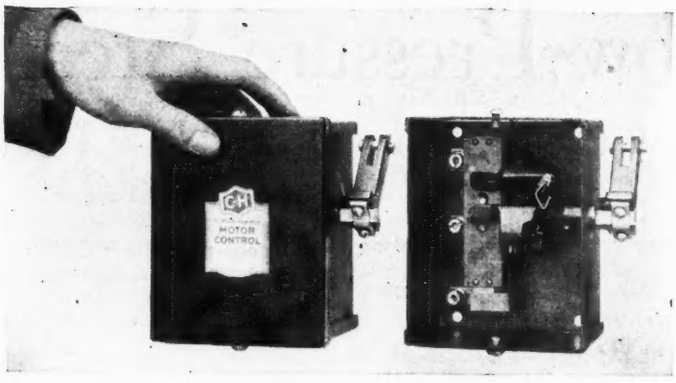
New "Newark" Testing Sieve

THE Newark Wire Cloth Company, 351-365 Verona Ave., Newark, N. J., has recently developed a new testing sieve which is equipped with an improved type of joint. A nest of these sieves is shown in the accompanying illustration.

Testing sieves with rounded joint

An important advantage of this new sieve is that the inside corner is rounded instead of sharp. Another improvement is that all soldering is done on the outside and not on the inside. This is a decided advantage when the wire cloth becomes so worn as to need replacing, as it can readily be done by melting the old solder off and then soldering the new piece of cloth on. This is all accomplished without distorting the cloth.

These sieves are made in 3, 5, 6, 8, 10 and 12-in. diameters and in accordance with U. S. Bureau of Standards specifications.



Master switch inclosed and with the case cover removed

Master Switch for Shipper-Rod Operation

A NEW switch, designed especially for splined shaft or shipper rod operation, is announced by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. This switch is for use as a pilot circuit control device on lathes, textile machinery and other equipment where starting and stopping of the machine is to be governed by a splined shaft, shipper rod or similar device.

Low-voltage protection is one of the important features. Should the motor stop, owing to low voltage or for any other reason, it will not restart until the switch has been operated again. Accidents and damage to machines caused by unexpected restarts are thus eliminated. The operating lever can be placed in any one of four operating positions, 90 deg. apart, to suit any installation requirement. The switch is designed especially for three-wire control, but can also be used for two-wire control on pilot circuits up to 550 volts.

The mechanism is protected against damage by a shear pin. This pin fastens the operating mechanism to the mainshaft, and any undue strain will cause the pin to shear, making the switch inoperative. Extra shear pins can be carried in stock and inserted after the trouble has been cleared. A heavy pressed steel, dustproof inclosing case, arranged for conduit wiring, protects the switch and prevents contact with live parts.

"Dualarc" Engine-Driven Direct-Current Welder

IN THE gasoline-engine-driven direct-current welding unit brought out by the Electric Arc Cutting & Welding Company, 1202-1208 Maccabee Building, Detroit, Mich., illustrated herewith, several important features have been incorporated in the design which make the unit adaptable to other services in addition to welding.

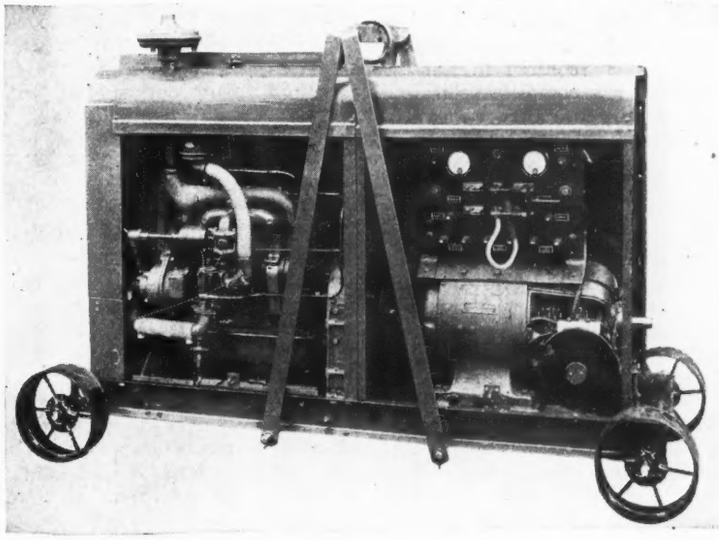
The generator is equipped with slip or collector rings which produce an alternating-current supply for the operation of electric drills, lights and grinders. This current can also be used for nickel spotting or semi-flashlight as used in repairing scored cylinders. This feature is also convenient in case of night welding or welding when electric current is not available.

The generator is also designed for reserve voltage. The series field is compounded so that a reserve voltage of 40 is always available to take care of voltage drop when long welding leads are used. The extra voltage also prevents the arc from being blown out so readily when operating in a high wind. Independent control of the voltage and amperage is provided. This feature makes it possible to attain practically any welding heat desired and makes the welder adaptable to a wide range of welding applications.

The generator is equipped with interpoles to improve the commutation. It is self-exciting and is so designed that the series field cannot reverse or overbalance the shunt field, it being impossible to overload the generator, as the voltage falls to a low value and the machine can be left on short circuit indefinitely without injury.

To meet unusual conditions or to compensate for incorrect adjustments of the voltage or amperage by the operator, the unit is equipped with a spring-reactor type stabilizer connected in series with the welding circuit. This reactor tends to overcome the effect of current variation and to maintain a stable arc automatically.

The generator is ball bearing throughout and is provided with a shaft extension which can be used as a power take-off for an air compressor or other service. The generator is driven by a model B-20 four-cylinder Continental gasoline engine equipped with a centrifugal mechanical governor. The ignition system of the engine is interlocked with the oiling system, so that the engine will stop automatically if the oil supply runs low. The generator and engine are close-coupled by a type of coupling that acts as a ventilating fan. The units are made in 150-, 200-, 300- and 400-ampere ratings.



"Dualarc" model S gasoline-engine-driven generator

Utilizing Low-Pressure Steam

By Warren B. Lewis
Consulting Engineer, Providence, R. I.

"Power installations in industries using process steam should be based on the industrial heat requirements and not on considerations of power-house efficiency," says Warren B. Lewis in a paper read before the Technical Association of the Pulp and Paper Industry.

A FEW years ago a young engineer connected with a paper mill read a paper before one of the meetings of the American Society of Mechanical Engineers in which he analyzed the power and heating requirements of a paper machine and arrived at the conclusion that an engine which utilized 50 lb. of steam per i.hp. would exhaust just enough steam to serve the subsequent purposes of the paper machine. Here is one of the most glaring examples of misapplied principles and misdirected effort. Had a source of mechanical power been used which utilized but 25 lb. of steam per i.hp., sufficient power would have been developed not only to drive the paper machine but to drive another one like it or some other machinery not utilizing low-pressure steam.

In a cotton piece-goods finishing plant with which the author is familiar, there are many small engines driving drying cylinders, printing machines, tenter frames, etc., the exhaust steam from these being delivered into a general main from which low-pressure steam is taken for drying and heating purposes. There is no evidence of any exhaust steam being discharged to the atmosphere, and the management believes that the so-called heat balance is nearly perfect. In the main engine room of this plant there are large prime movers operating condensing with at least 85 per cent of the heat of the steam being discharged with the condensing water. If this particular plant used prime movers ejecting 18 to 20 lb. of steam per i.hp. and operated non-condensing, all the mechanical power required would be generated with no heat to be discharged either to the atmosphere or through a condenser.

A well-balanced worsted mill, finishing its own goods, can develop all the mechanical power required to run the entire plant with a complete utilization of latent heat, excepting that represented by radiation and stack losses.

In a small paper mill with which the author is familiar, a complete study of the mechanical power and heat uses has resulted in a reduction of fuel and labor charges by an amount which, to say the least, is highly satisfactory to the management. Yet previous to the alterations the belief existed that the so-called heat balance left little to be desired.

The greatest error is made in the manner of approach. The whole situation is too often worked out by beginning at the wrong end. The start is made in the boiler room, whereas that should be the finishing point. Endless papers have been written and read on boiler efficiency, turbine and engine efficiency, modern developments in furnaces, methods of firing coal, whereas the greatest waste comes from the improper application of heat and power.

The underlying principle that governs the design and operation of a public utility plant is radically different from that pertaining to a manufacturing plant, in that in the former the product sold is power which must compete with the isolated plant in cost, while in the latter case power is but an incidental item and in many cases may be simply a byproduct. In any event power, in any of the industries previously mentioned, is so indissolubly linked with the necessities of the process that the two must be considered as one, else the design will be faulty.

Study Heat Requirements

The correct method of approach is to study first the minimum requirements for heat, and I stress the word minimum. It is an easy matter to dispose of exhaust steam, but it is not so easy to realize the greatest amount of heat from a given quantity of steam. We should, therefore, start our studies with an analysis of every process and every machine that utilizes heat and, if necessary, make such changes in equipment as will reduce the amount of heat required to a minimum.

In a paper drier, for example, the first step is to dry the paper with the least amount of steam. This may require a change in the method of draining water and air from the driers or of increasing the velocity of steam through the driers, and possibilities along this line have been by no means exhausted. It may mean a combination of steam in the driers and hot air outside, and if the latter is used the method of heating the air should be given its due consideration. In any event low-pressure steam can be used and preferably at a pressure no higher than is absolutely necessary. This may mean more surface in the apparatus itself, and it is rarely that additional heating surface will not be justified from the view of true economy.

In certain types of apparatus, such as bleach boilers, operations can be started with hot water heated by low-pressure steam, resulting in not only the quickening of the process, but a real economy in the use of heat.

Heating systems will operate successfully at atmospheric pressure even when units are a long distance away from the source of heat. It may be necessary to increase the amount of heating surface or to take the necessary steps to circulate the steam through the system; but again, it is rare when this is not justified from the point of view of true economy.

In worsted dyeing it has been customary for years to use high-pressure steam in the dye kettles, and there are few dyers who will believe that the work can be done equally well with low-pressure; and yet by starting with hot water the dye kettle can be boiled in less time and with less steam at a pressure of 5 lb. than at a pressure of 100 lb., but the piping arrangements will have to be entirely different.

If, therefore, in any plant we start first with a list of machines utilizing heat in one form or another, and then determine the way in which low-pressure steam can be substituted for high pressure, and, furthermore, how to obtain the final heat with the least amount of steam, we will find that we have reduced the total amount of live steam used and increased the amount of low-pressure steam.

Conserve Heat Units

The next step is to conserve the heat that performs no useful work. This is not so simple as the statement might make it appear, because it involves the calculation of pipe-line sizes for minimum losses and the elimination of every foot of pipe that is not absolutely necessary.

We finally arrive at a figure representing the total amount of low-pressure steam required for any given condition of operation, but we must repeat this analysis for other conditions, such as part-time operation and excessive production, that we may have an average figure (as well as a maximum and minimum) which will represent operations as they may have been carried on over a period of years.

So far we have forgotten mechanical power, nor are we greatly concerned except to obtain all that we can from the steam which leaves the boilers at one pressure and is ejected from the power

unit at a lower pressure. It is evident that if we have used our wits to devise methods whereby the exhaust pressure is the minimum possible, certain benefits will accrue. Not infrequently, there are cases where a small percentage of the machinery cannot be operated at quite as low a pressure as the remaining, and it may be better to utilize direct steam rather than to sacrifice the entire system.

Consider Prime Movers and Steam Use

As it is evidently desirable to obtain the greatest amount of mechanical power possible from a given amount of steam, we must consider types of prime movers and initial pressures. If we can get 50 per cent more mechanical work out of a turbine operating with an initial pressure of 350 lb. and an exhaust pressure of 5 lb. than we can from one with an initial pressure of 150 lb., we cannot afford to overlook that fact. In our design, whether for new construction or in reconstruction, we must bear in mind the ultimate, although we may have to sacrifice something temporarily. The same consideration must be given power-plant auxiliaries, choosing a type that will require the least amount of steam for the mechanical work performed, and we finally arrive at the amount of steam required at the boiler nozzle to manufacture so many tons, yards or bushels of product.

I would not belittle the importance of recent boiler designs, boiler settings, methods of firing, etc.; but more stress has been laid upon this than upon the subsequent uses of steam, and it is my belief that for a given sum of money more can be accomplished between the boiler nozzle and the finished product than between the boiler nozzle and the coal bin.

The writer is familiar with instances where it is possible to produce more mechanical power than can be used. In such cases the amount of low-pressure steam ejected from the prime mover is insufficient and live steam must be admitted. This is almost an ideal condition, because with decreased production the balance is favorable, while with increased production live steam is admitted to the low-pressure system with no loss of heat.

Power that is not a byproduct is in direct competition with public-utility power.

As an application of the principle stated in the foregoing, the writer refers to a textile finishing plant wherein the requirements of power and heat are very similar to those of a paper mill, although the balance between the two may be quite different. In this plant there was one cross-compound condensing engine developing 450 i.hp., one simple condensing engine developing 250 i.hp., one simple non-condensing engine developing 250 hp., and 26 small engines rated from 10 to 30 hp., all exhausting into processing apparatus. Under the most favorable rate of production all the exhaust steam was used at a pressure of about 12 lb., but at any other rate of production there was either a deficiency or excess of low-pressure steam.

The processes involved boiling out, drying, preparation of liquors, heating of the buildings and the use of heated air for vapor absorption. Besides these were various processes requiring steam at boiler pressure. Steam was generated in thirteen boilers operated normally at rating, and the actual amount of low-pressure steam used expressed in horsepower was about one-half of the total steam generated.

The first operation requiring heat was the boiling-out process, which was done by introducing liquors into bleach boilers, and boiling at 12 lb. pressure for about 12 hours with live steam. This operation was changed by heating the liquors with low-pressure steam before they were run into the boiler and by using low-pressure steam through a circulating system until the whole mass had reached a temperature very near that of the steam. Live steam was then introduced to continue the boiling at a temperature higher than that of the low pressure steam.

The Drying Operation

The next step in the process was the drying of the material on copper cylinders. Steam at 10 lb. pressure was used from the exhaust of a small engine, and the balance between the power and the heat was nearly perfect. The piping of these cylinders was changed so that the steam passed through various sections in series and the water and air were withdrawn by a vacuum pump, resulting in the use of less steam at a lower pressure, whereupon the amount exhausted from the engine was in excess. There were ten sets of driers in this plant, all of which were altered in a similar manner, and it at once became apparent that the amount of steam derived from the small engines was greater than was necessary for drying.

The third process was drying cloth after it had been starched, on what is called a tenter frame. This drying was done with live-steam coils under the cloth, and the exhaust from the small engine driving the frame was not used at the machine. A large fan with low-pressure heat coils was installed, and air heated to a temperature of 200 deg. was blown on the cloth as it passed through the frame, resulting in a much more rapid removal of moisture, a higher rate of production in the machine and the elimination of the use of live steam.

In the dyehouse ceiling condensation was prevented through the use of live-steam coils close to the roof. This was replaced by circulating warm air heated with low-pressure steam. In the mercerizing department liquors were heated with live-steam coils placed in vats, the temperature of the liquors being 150 deg. F. This was altered by pumping the liquor through a closed coil heater with low-pressure steam in the shell.

The heating system of the plant consisted of high-pressure steam coils draining back to the boilers through return traps. This was changed at considerable expense to a vacuum system to operate at less than 5 lb. All the small engines were taken out and electric drives substituted, using variable-speed motors, and as the work progressed it was evident that the amount of steam being derived from the non-condensing engines was insufficient owing to the fact that the Corliss non-condensing engine could develop more power per pound of exhaust steam ejected than could the small engines, or, to express the matter in another way, the mechanical power requirements remaining constant, there was less steam in the exhaust main. To correct this deficiency, the simple condensing engine was operated non-condensing and ultimately the cross-compound engine was operated as a simple non-condensing engine, the low-pressure cylinder being disconnected.

Power being produced with engines ejecting 25 lb. of steam per i.hp., as against probably 70 lb. with the small engines, the reduction in the amount of exhaust steam available was sufficient to make it necessary to inject live steam into the system through a reducing pressure valve. At first thought it might seem that little could be gained in doing this, but actually the heat that had been discharged through the condensers was being recovered and the flexibility of operation had been tremendously increased. Hundreds of feet of high-pressure steam pipe were removed and the piping system reduced to the utmost simplicity. The boiler load was reduced to the capacity of seven boilers, and the total amount of steam used per yard of cloth finished was reduced one-third.

What a Balance Gives

In this plant no steam is ever exhausted to the atmosphere or to a condenser, and barring the unavoidable radiation losses, the use of fuel has been reduced to a minimum. In fact, in this plant it would be possible to develop 200 hp. for delivery outside of the plant if there were a complete balance between the power and the low-pressure steam requirements.

This is by no means an unusual case, and power-plant engineers will recognize the possibility of repeating this performance in plants with which they are familiar.

To sum up, the writer emphasizes the following points:

1. Temporarily forget the mechanical power requirements and the boiler plant and study the uses of heat.

2. Every operation requiring heat should be done with low-pressure steam wherever possible.

3. Reduce the amount of low-pressure steam to a minimum through the study of machines and processes.

4. Adopt a type of prime mover that will give the greatest amount of mechanical power per pound of steam ejected.

5. Spend your money first on improving apparatus and piping systems utilizing low-pressure steam before worrying about the boiler plant except for some other reason than efficiency.

Motor Selection, Anti-Friction Bearings and Power Cost

Feature Proceedings at A.I.S.E.E. Convention

FROM June 25 to 28, inclusive, the Association of Iron and Steel Electrical Engineers held its twenty-fourth annual convention and the iron and steel exposition at the Stevens Hotel, Chicago. As the district surrounding the city is one of the largest steel centers in the country, the attendance was exceptionally good, and the interest shown in the seven technical sessions indicated that the program covered topics of current and vital importance to the steel industry. The final registration approximated 800, and this does not include a large attendance to the exposition at which nearly 100 exhibitors displayed products pertinent to the field.

Special functions of the convention were an informal luncheon under the auspices of the Safety Engineering Division of the Association, addressed by L. H. Burnett, vice-president of the Carnegie Steel Company; an informal reception in the Grand Ball Room of the Stevens Hotel; an informal luncheon at which J. B. Taylor, of the General Electric Company, gave a demonstration of "making sound visible and light audible"; an informal luncheon featured by a demonstration of the Wensley televox, or automatic man, by J. L. McCoy, of the Westinghouse Electric & Manufacturing Company; and on the final evening of the convention, the annual reception and formal dinner dance.

Officers elected for the ensuing year were as follows: President, C. S. Proudfoot, Vanadium Corporation of America; first vice-president, F. W. Cramer, Bethlehem Steel Company; second vice-president, A. G. Place, Youngstown Sheet & Tube Company; treasurer, James Farrington, Wheeling Steel Corporation; secretary, A. A. Stewart, Pittsburgh Steel Products Company; director at large, Karl Landgrebe; engineering section directors, M. J. Conway, combustion; E. F. Blank, safety; directors, N. Tull, E. L. Upp, J. E. Sayer, R. M. Hussey and P. T. Vanderwaart.

Electrical Developments of the Year

Committee reports, summarizing developments and giving typical operating data, occupied the first session of the convention. The Electric Heating Committee, G. H. Schaeffer, chairman, pointed to the downward trend of power cost and the many advantages that make industrial electric heating desirable even though the B.t.u. cost is higher than for other mediums.

Electrical developments in the iron and steel industry was an interesting committee report, given by the chairman, W. H. Burr, in which the characteristics and design details of main-roll motor installations, and their rapid increase in number, were considered, as well as the development in cranes, auxiliary motors, magnets and oil switching and control equipment. It was interesting to learn that in January, 1928, over 1,500 main-roll drive motors in the United States and Canada had been reported. During the year 1927 there had been purchased 122 main-roll drive motors ranging in size from 300 to 7,000 hp. Of this number 63 were direct-current motors, 40 were 60-cycle, 17 were 25-cycle, and two were 50-cycle alternating-current motors. Thus more than one-half were direct-current motors, a condition quite different from that existing a few years ago; and of the total number for the year, 80 of these motors were used in connection with gear drives, giving concrete evidence that the modern reduction gear has proved its reliability to the satisfaction of the steel industry.

As the report of the Standardization Committee, A. C. Cummings, chairman, gave in their final corrected form the outline dimensions for the Association's standardized mill-type motor.

High-Tension Practices

In a session devoted to high-tension practices three papers brought out present-day practices in central-station and steel-mill plants. Eugene Vinet, assistant to the vice-president of the Middle West Utilities Company, summarizing latest practice in high tension, 33,000 volts and above, limited his remarks to step-up and step-down substations, including transformers, switching equipment and the interconnecting transmission lines. F. O. Schnure, electrical superintendent of the Bethlehem Steel Company at Sparrows Point, discussed high-tension practices in steel mills tending toward safety, while R. M. Hussey, electrical superintendent of the Jones & Laughlin Steel Corporation, outlined briefly the rules and regulations used in operating safely the high-tension power system of a typical steel plant.

Motor Selection for Roller and Mill Drives

J. C. Dobelbower, engineer of the Crocker-Wheeler Electrical Manufacturing Company, described briefly the several different designs and applications of "roll out" motors now being used with success on "roll-out" tables in various mills in preference to the older group type of motor drive. The latter, whether of the cable-and-sheave or bevel-gear type, lacked flexibility in that the individual rollers cannot be controlled. In case of motor trouble or breakage of cable or gears, the entire table is out of commission, whereas with the roll-out motor drive, the failure of a driving motor affects only the one roller, and a number of motors in the train can fail without a shutdown of the table. Also, it would be quite feasible to shut down some of the motors to produce a drag on the speed of the strip or bar if desired. In the author's opin-

PROMINENT in the yearly review was the increasing use of electric drives on main rolls in steel plants and the trends toward synchronous motors for constant speed and direct-current motors for variable speed. Full sessions were devoted to motor selection for main drives and the use of anti-friction bearings. Papers on the purchase of coal and a new method of figuring steam and power costs were of special interest to the power producer and the designing engineer.

ion upkeep costs would be less with the roll-out motor drive, and it was his conclusion that the future would see most of the mills in the country equipped with individual motor drives on their roll-out tables.

Selection of main drive motors for strip and skelp mills was the subject presented by A. F. Kenyon, general engineer of the Westinghouse Electric & Manufacturing Company. The paper was largely devoted to methods of calculating the power demand and therefore selecting capacities of driving motors, rather than the particular type of motor, as the choice of motor could be made only after a careful study of the individual case.

C. B. Huston, industrial engineering department of the General Electric Company, has prepared an elaborate treatise covering the selection of motors for the main drives of merchant, bar and rod mills. In order that the audience might gain some knowledge of the applications that have been made of motors to these mills and at the same time to show that the kind of mill and the particular layout of the mill might affect materially the choice of motor as to type, capacity, speed and method of control, a number of different types of mills and their drives were described, and a bit of history covering important stages of development was reviewed to show the reasons for present-day practices.

Although these descriptions brought out the fact that almost every existing type of alternating-and-direct-current motor and almost every conceivable form of speed-adjusting equipment were in use, the author pointed out it was not until early in the present year that the first synchronous motor had been sold for driving either a rod or merchant bar mill. Where constant speed sufficed, he predicted that the future would see more synchronous motors in use.

Anti-Friction Bearings

Owing to the importance of the subject an entire session was devoted to the application of anti-friction bearings to the various types of drive in a steel mill. Three papers were presented. J. H. Van Campen, chief engineer of the E. W. Bliss Company, discussed the application of anti-friction bearings on the roll necks of rolling mills. During the last year many installations had been made. Four types of bearing had been developed—ball, straight roller, taper roller and spherical roller. The success of these bearings depended upon the selection of the proper type and size, the proper mounting of the bearing on the roll neck, and the lubrication of the bearing. These various factors were considered along with typical mountings for the four types of bearing. The use of anti-friction bearings afforded a power saving of 40 to 50 per cent, a saving in lubrication and, by giving better control of tolerances on finished products, a reduction in rejections.

"Anti-Friction Bearings for Electric Motors" was the subject of a symposium compiled by J. S. Murray, electrical engineer of the Follansbee Bros. Company. Anti-friction bearings had been so generally adopted for steel-mill motors in the last few years and the subject had become so important that the association maintained a committee as a clearing house for information on the subject. To give a general idea of what the market afforded, the committee asked several manufacturers of the outstanding types of anti-friction bearing to summarize briefly what they made and give the advantages to be derived from the special form they had adopted, this to form a basis for discussion on the subject. The contributors were S.K.F. Industries, Inc., Hyatt Roller Bearing Company, Timken Roller Bearing Company and the Norma Hoffmann Bearings Corporation. Anti-friction bearings of all general types, therefore, were considered, including roller, ball, cone and spherical. It is interesting to point out that in one of these reports a survey on five representative plants had showed the following savings effected annually by the use of anti-friction bearing motors: For lubrication, 83.8 per cent in lubricant and 74 per cent in labor; and 85 per cent in maintenance and repairs.

In the final paper of this session Ernest S. Jefferies, electrical engineer of the Steel Company of Canada, Ltd., reviewed and set forth in a general way the most prominent applications of anti-friction bearings to a wide varity of auxiliaries in the iron and steel industry.

Recording Instruments

A valuable paper dealing with the use and value of recording and controlling instruments in the iron and steel industry was collaborated by C. C. Eagle and Roy M. Walker, electrical engineers of the Bristol Company. The treatise was limited to applications bearing upon the metallurgical phase of the industry, and no reference was made to the many requirements of the power plant. Beginning with the use of recording and controlling instruments in the iron and coal mines and the limestone quarry, the authors traced their use through the blast furnace, the coke oven and by-product departments, etc., right down through the other departments, such as the tube and rod mill, the sheet and tin-plate mill, until the former ore has been transformed into a finished product. Classified according to the departments, these instruments were listed in a comprehensive table covering all possible uses.

High-Pressure Boilers

On the general subject of power there were three papers. Under the title "Boiler Pressure Above 500 Pounds," J. B. Crane, of the Ladd division of the Combustion Engineering Corporation, reviewed the theory of high pressures, commented upon the reheat cycle, pressure limits, features of construction differing from those for lower pressures, fittings and the economies to be anticipated. The 1,400-lb. pressure units thus far installed had been superimposed on 350- or 400-lb. plants, so that no condenser was required. On this basis and when all the steam in the station was passing through the high-pressure unit, a theoretical saving of 12 per cent in the coal was possible and had been obtained in practice. Referring to two 1,400-lb. stations under contemplation, which will contain no lower-pressure boilers, the estimated cost was about $110 per kilowatt, as compared to $90 for a 450-lb. system. Operation was no different from that of lower-pressure units, and it was surprising how little trouble had developed considering the rapid progress that had been made in these high pressures.

Purchasing Coal

Morgan B. Smith, engineer of the General Motors Corporation, gave a comprehensive analysis of the various factors governing the purchase of coal. In his opinion the proper selection of coal was the most important single factor leading to improved efficiency in the plant. Leading factors entering into coal selection were a study of the boiler plant, the general characteristics of the coal field or district or seam, the contents of the coal and the ash-sulphur ratio, location and operating methods of the mine, rating of the coal vendor, checking the quality of the coal delivered, effect of coal size on price, routing and scheduling of shipments, the purchase contract and price agreements. The author believed that the most practical specification for purchasing coal was one covering coals of known general qualities and laying special stress upon preparation. Bonus and penalty clauses in the case of industries might work well provided the penalties did not overtop the bonuses, but the value of such clauses in general was open to serious doubt. Typical specifications covering the chemical and physical properties of the coal and the premiums and penalties on ash content were given and suggestions presented for a coal-contract form and for the study of coal-mining districts and individual mines.

Cost of Steam and Power

A paper unique in the method of treatment was that by W. B. Skinkle, who analyzed the elements entering into the cost of the production of steam and electric energy and placed them in their proper relation to each other. Instead of comparing costs per kilowatt-hour in the usual way, the author separated the total cost of energy per month into a constant cost independent of the production and an increment cost, directly proportioned to the quantity of energy produced. A similar plan was followed in the boiler room. Graphical representations were given and the theoretical conception applied to actual cost sheets. A study of the author's methods will show why estimated savings from the installation of new equipment seldom materialize and bring out the important bearing load factor has on the investment in the power equipment that is justified for a given station. The paper created a sensation at the meeting, and the probabilities are that it will revolutionize cost-accounting methods in the steel industry.

Smoke Prevention Association Holds Annual Convention

THAT the prevention or elimination of smoke is a live subject at the present time was evidenced by the large attendance at the Twenty-second Annual Convention of the Smoke Prevention Association held at the Hotel Seneca, Rochester, N. Y., June 26 to 29 inclusive.

In opening the meeting the president, Andrew J. Glascott, said that the more active interest being taken in smoke abatement by the public officials in the various cities throughout the country was due to public opinion and to the concerted action on the part of civic clubs and organizations for cleaner air. He predicted that the time was not far distant when the smoke department would be one of the most important in all large cities. He said, in general, the railroads had been willing and anxious to help solve the problem, but that could not be said of the various industries, for in most cases it had been difficult to get their co-operation. He said it was generally recognized that in the matter of smoke abatement the City of Rochester was well to the front.

An address of welcome to the members of the Association was given by Mayor J. C. Wilson, who was followed by the city manager, Stephen B. Story, and Commissioner of Public Safety, George J. Nier. In reviewing Rochester's problem in the matter of smoke elimination Mr. Story said:

Rochester's Problem

"Rochester's problem is not different in its essential aspects from that of most urban communities in this country. We are more fortunate than some cities in that our household heating plants, with the exception of the increasing number burning gas and oil, practically all use hard coal. This condition enables us to confine our attention to the plants of larger size. One of the first things done was to devise a practical means of spotting offenders and checking them up. A special telescope fitted with an azimuth circle and an altitude circle enables us to plot the location of a stack which belches smoke of an offensive character. By locating the stack on the map, its readings soon become known to the observers. The observation station is in the tower of one of the highest buildings and is approximately 200 ft. above the main street.

"The telescope is equipped with a screen to enable the observer to determine the density of the smoke. The plotted stacks number about 400, and we have a card record of the 1,800 that are now in operation."

At the afternoon session a paper on the "Requirements for Heating Boilers for Smokeless Combustion," was read by T. A. Novotney, sales engineer of the National Radiator Corporation, Johnstown, Pa., and a paper by Homer L. Linn, of the American Radiator Company, Chicago, on the "Relation of Chimney to Smoke Prevention." The paper by Mr. Novotney dealt with the advantages and disadvantages of the down-draft furnace as compared with the modern up-draft furnace, and with the requirements of the modern heating boilers to insure smokeless combustion.

In the absence of Mr. Linn his paper was read by F. E. Reidhead smoke inspector of Minneapolis. The paper dealt with the relation of chimney draft to capacity obtained from a boiler and chimney troubles in general. An instance was cited where a boiler designed to supply 11,000 sq.ft. of radiation was able to burn sufficient fuel, owing to the strong draft, to carry 22,000 sq.ft. of radiation, but the fuel consumption was excessive. After another boiler was put on, the coal consumption was reduced more than a ton per day. Mr. Linn included in his paper a chimney specification to be used by architects, engineers and builders, designed to overcome the many troubles now existing, due to faulty chimney construction.

New York City's Problem

At the morning session on the second day addresses were presented by Joseph M. Lonergan, chief sanitary inspector of New York City; Dr. George W. Goler, health officer, Rochester, on the subject of soft coal smoke and health; Joseph A. Harrington, of the King Coal Stoker Company, Chicago, on "Abating Smoke in Heating Plants with Stokers"; and Louis C. Whiton, of the Pratt-Daniel Corporation, New York City, on the "Removal of Soot and Cinders from Flue Gases."

Mr. Lonergan spoke briefly on the smoke problem of New York City, which he explained was confined to a few plants and water craft. He said there were several large pulverized-coal plants in the city which did not give any trouble from smoke, but did to some extent constitute what might be termed a cinder nuisance. He said that the department had made tests on the various devices designed to eliminate smoke in heating boilers, and had found the method that gives the air and gases a turbulent action in the furnace by means of steam jets or other apparatus to be the most effective.

Doctor Goler dealt with the smoke problem in its effect upon the general health of the community. He said that before the smoke inspector got busy, Rochester had as much smoke as London, but that it had been reduced 30 per cent.

Mr. Harrington reviewed the small boiler plant situation as he found it while connected with the United States Fuel Administration board during the War, his experience covering broadly 13,000 plants burning various grades of coal. He also reviewed the evolution of the inclined shaking grate and hand stoker up to the automatically controlled mechanical stoker now in use for small heating plants and industrial furnaces, and its importance as a factor in the elimination of smoke. He pointed out that a stoker, to be successful in plants of this type, must be capable of maintaining a uniform fuel bed, free of holes and to dispose of the ash regularly and effectively.

Cinder Elimination

The address by Mr. Whiton dealt with the various methods of eliminating cinders from gases discharged from chimneys. As an indication of the extent of this problem he cited one instance where 100 lb. of cinders per hour were discharged from an 8,000-sq.ft. boiler. When the tubes were blown with the mechanical soot blowers, which required about eight minutes and was done once on each shift, an average of 125 lb. of cinders were discharged.

The first speaker at the afternoon session was I. E. Powell, of the Rochester Gas & Electric, who spoke on "Central-Station Heating in Relation to the Elimination of Smoke." Mr. Powell pointed out that central-station heating contributes both directly and indirectly to the general cleanliness and health of a city, for not only are the modern central-station heating plants of a high standard in design operating at high efficiency with good combustion and little smoke, but they eliminate a multiplicity of small plants which, as a general thing, are potential sources of objectional smoke, and also do away with the delivery of coal and the collecting of ashes at hundreds of different points in the city.

The final paper of that part of the convention, devoted to the elimination of smoke from power and heating plants, was presented by Harlan W. Bird, of the M. A. Hofft Company, Indianapolis, Ind., on the subject of "Burning Wood Refuse Smokelessly." Mr. Bird described the latest method of handling wood refuse as one in which it was reduced in a hog to sizes around $\frac{1}{4}$ in. diameter and 1 to 2 in. long, then transported by screw conveyors to the boiler and passed through a paddle-wheel feeder designed to give a uniform feed to the furnace and to prevent an excessive amount of air entering with the fuel. In the furnace the large particles are burned on an inclined grate with an overhead flat arch to maintain ignition of the wet fuel, and the finer particles are burned in suspension.

NEWS OF THE FIELD

The editors will welcome the co-operation of readers in reporting interesting happenings, personal or otherwise

McGraw-Hill and Shaw Company Merge

Consolidation Affects Large Number of Engineering and Industrial Papers—Shaw and McGraw-Shaw Companies Become Divisions of McGraw-Hill

A CONSOLIDATION affecting two large publishing interests has just been brought about by the merger of the McGraw-Hill Publishing Company, Inc., of New York and the A. W. Shaw Company of Chicago.

The Shaw organization publishes the *Magazine of Business, System* and the *Industrial Distributor and Salesman*, while the McGraw-Hill organization is the publisher, either directly or through subsidiary and affiliated companies, of more than twenty leading business papers, including POWER, and of engineering and business books. The two companies have had a close relationship since last fall, when they jointly formed the McGraw-Shaw Company, which publishes *Factory and Industrial Management* and *Industrial Engineering*.

A. W. Shaw will continue as chairman of the board and James H. McGraw will become president of the A. W. Shaw Company. Mr. Shaw will also become a director of the McGraw-Hill Publishing Company, Inc., and will continue as president of the McGraw-Shaw Company. Wheeler Sammons will become a director and member of the executive committee of the McGraw-Hill Publishing Company and senior vice-president and general manager of the A. W. Shaw division of the business, which will be known as the "A. W. Shaw Company, a division of the McGraw-Hill Publishing Company, Inc." The McGraw-Shaw Company will also be operated as a division of the McGraw-Hill Publishing Company.

Two reasons for the merger are stressed by the officers of the merging companies. The magazines of the two organizations are complementary in character. The Shaw papers cover business broadly, giving the business man an understanding of what is going on in all branches of trade, industry and finance. Their service is extensive in character. The McGraw-Hill service, on the other hand, is intensive. Its magazines give a highly specialized service to given major industries and to related industrial groups. Thus the consolidated companies serve the business man in both his general and special business interests. The second reason is the very evident economy and increased effectiveness of consolidated operation, enabling a superior service to be rendered to the whole sweep of American business. Mr. McGraw said:

"Mr. Shaw's organization and ours have been working closely together for more than a year and have seen the benefits of consolidated effort between groups having widely different publishing experiences. The Shaw company has had a signal success in publishing magazines of large circulation and of broad appeal to the industrial and business worlds. The McGraw-Hill company has intensively served by specialized publications the leading engineering industries and the trade channels for distributing their products.

"It was apparent that the McGraw-Hill group of industrial and trade papers would have a new way of carrying the message of common business problems if it was allied with papers like the *Magazine of Business* and *System*. At the same time these publications would be immeasurably strengthened by being tied in with and assisted by the great editorial staff of over one hundred and thirty industrial and business specialists who edit the McGraw-Hill papers. There were also conspicuous opportunities for more effective subscription and advertising work and for economies in every phase of publishing. The logic of these opportunities could not be escaped. The merger has been the result.

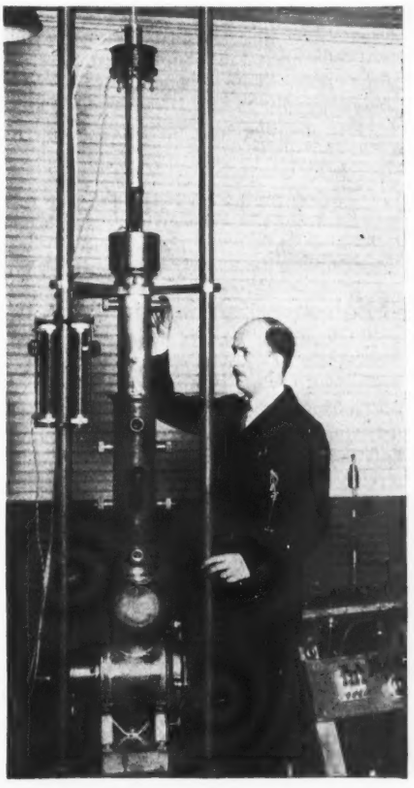
"Though every paper of the merging companies will be strengthened by the consolidation, and thus render greater service to its readers and advertisers, the most conspicuous result will be the new and strong position of the *Magazine of Business*. Through Mr. Shaw's vision and courage it is a magazine of strength, standing and influence. It now becomes the capstone of the virile group of papers and the other publishing activities of the McGraw-Hill company, thus extending the scope of the latter organization to the whole range of American business. At the same time, drawing on the intimate contact with trade and industry of the large corps of McGraw-Hill specialist editors, it will speak with unexampled authority on the problems of business. It will be able to render an outstanding service to the business men of America by its authoritative information, its expert interpretation and its fearless advocacy of sound business policies. It will fight for the interests of business, but it will place in an equally important position the responsibility of business to the public. It will, in a word, stand for true business statesmanship."

Mr. Shaw expressed his gratification over the merger in a similar vein.

Lightning Characteristics to Be Studied on Tennessee Mountains

During the next six months, according to W. S. Rugg, vice-president of the Westinghouse Electric & Manufacturing Company, electrical engineers of his company, armed with every scientific device obtainable, will record each bolt and quirk of every thunderstorm that plays around the crest of Chilhowee mountain, Tennessee.

Since the site where the apparatus is to be located, Chota, Tenn., has an



The Norinder Oscillograph

average of twenty thunderstorms each month during the summer, the engineers will probably have an active time.

The instruments used by the engineers, who will spend the next six months or six years, if necessary, on the job, will consist of Norinder

oscillographs, osisos, klydonographs, cameras and other apparatus, not only to record but also to diagnose the effect of each lightning flash. This apparatus, to be installed on the power lines of the Aluminum Company of America, will cover a five-mile stretch of wild terrain.

Of supreme interest to scientists will be the installation of the Norinder oscillographs. They will reveal, according to engineers, characteristics of lightning which scientists have sought to discover for centuries.

Dr. Harald Norinder, Westinghouse consulting engineer and inventor of the apparatus, ranks today as the foremost authority on lightning. This distinction is the result of eight years' study in Sweden as engineer and head of the Research Bureau of the Royal Board of Waterfalls in Stockholm. Last spring he personally brought his oscillograph to Westinghouse headquarters in East Pittsburgh, Pa., to demonstrate its abilities. Impressed by the entirely new theories involved in its construction, Westinghouse executives arranged that the apparatus be made available for American engineering work. The Tennessee installation followed.

The installation of equipment will be made on either side of the highest peak of the Chilhowee Mountains. A Norinder oscillograph will be located on either side of the mountain peak with two klydonographs installed one-half mile from either side of each oscillograph.

The oscillograph operates much like the hidden automatic cameras by which wild animals are made to take their own pictures. Installed on the power line, it keeps watch for hours without attention. Any sort of lightning, from the smallest spark to a 100-million-volt flash a half-mile long, leaves an exact record of its performance on the Norinder instrument. The device measures the rate of rise of the voltage surge, the maximum voltage attained, the duration of the charge and the rate of decrease. It is so sensitive that it records surges that have an ephemeral life of only a ten-millionth of a second.

No mechanical device could be made to act so quickly, so the moving parts consist of a beam of cathode rays, which are bent by electric attraction and leave their mark on a photographic device. The entire apparatus is in a vacuum.

The klydonographs will record the maximum shock received by the transmission line and thus supplement the oscillograph records. Osisos will function as a part of distance finders to tell the operators how far distant from the power line the bolt of lightning flashed. The cameras will record any lightning within their range.

With this installation and with a crew of engineers on duty 24 hours each day for an indefinite period, it is expected that data concerning the effect of lightning on high-voltage transmission lines will be recorded in such detail that the development of lightning-proof apparatus will be greatly facilitated.

A. I. E. E. Holds Summer Convention At Denver, Colorado

High-speed circuit breaker, outdoor-type synchronous condensers cooled with hydrogen and adjustable-ratio frequency changers, are some of the outstanding features

In the scenic setting of Denver and at the Cosmopolitan Hotel as headquarters, the American Institute of Electrical Engineers held its forty-fourth Summer Convention. This location provided the members and their friends an opportunity to visit many points of scenic interest, for which the mountains of the West are noted. Outside of a personally conducted tour of eighteen days, which included Yellowstone Park, opportunity was afforded to take a number of short one- and two-day trips during the convention.

At the six technical sessions 34 papers and committee reports were presented, covering a wide variety of subjects. A paper by E. E. Dresse, on "Alternating Current Elevator Motors of the Squirrel-Cage Type," sets forth the design features that differentiate this type from the standard general-purpose motors. The type of motor considered is one designed for two speeds and has two stator windings. These motors are designed for speed ratios of two-to-one, three-to-one, four-to-one and six-to-one.

"Operating Experience with High-Speed Oil Circuit Breakers" is the title of a paper by B. F. Bardo, that outlines the experience of the New York, New Haven & Hartford Railroad with high-speed oil circuit breakers on 11,000-volt lines. This type circuit breaker was adopted as a means of minimizing the disturbance in communication circuits paralleling power lines. Its use has resulted in satisfactory operation of commercial as well as railroad communication circuits.

Three other papers—"The High-Speed Circuit Breaker in Service on the Illinois Central Railroad," by W. P. Monroe and R. M. Allen; "High-Speed Circuit Breakers for Railway Electrification," by H. M. Wilcox; and "High-Speed Circuit Breakers," by J. W. McNairy—discuss both oil and air-break types, and present many features in the application of these equipments.

Of the many committee reports the most comprehensive was that on electrical machinery, F. D. Newbury, chairman. One of the sections of this report, dealing with transformers, clearly indicates the vast change that has come about in the design of this equipment during the last five years. These changes involve means of changing the ratio of the transformers under load by changing tap connections in the windings; and voltage regulation by means of top-changing devices and voltage regulators, which means has been used to give 43 per cent regulation. These equipments have changed the appearances of the conventional type of transformer with a tank-like outside appearance to that of a complicated machine.

In the design of rotating machines welding has played a revolutionary part. This method is being applied to both high-speed and low-speed equipment and to large- and small-capacity generators.

For the last two or three years there has been considerable discussion on the use of hydrogen as a cooling medium in electrical rotating machines. Reference is made in the report to two synchronous condensers to be installed out of doors and to be filled with hydrogen. The smaller of these two machines, which has a rating of 10,000 kva. when operated in air, is guaranteed for at least 12,500 kva. when operating in hydrogen.

The adjustable-ratio frequency changer used to deliver power at a constant frequency of 60-cycles, from a 25-cycle system with a varying frequency, is another piece of equipment that has been adopted within recent years. One set rated at 25,000 kva. delivers power at a constant 60-cycle when the frequency of the 25-cycle system varies 2 per cent.

Coming Conventions

American Society of Mechanical Engineers, Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3; second national fuels meeting at Cleveland, Ohio, Sept. 17-20; Calvin Rice, secretary, 29 West 39th St., New York City.

Canadian Steel and Power Show at the University of Toronto Arena, Sept. 4-7; Campbell Bradshaw, secretary, 24 Front St., West Toronto, Canada.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

New England Water Works Association, annual convention at Montreal, Canada, Sept. 18-21, Frank J. Gifford, secretary, 715 Tremont Temple, Boston, Mass.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

World Power Fuel Conference at the Imperial Institute, London, Sept. 24 to Oct. 6.

Huge Ladle Transports Molten Steel Ten Miles

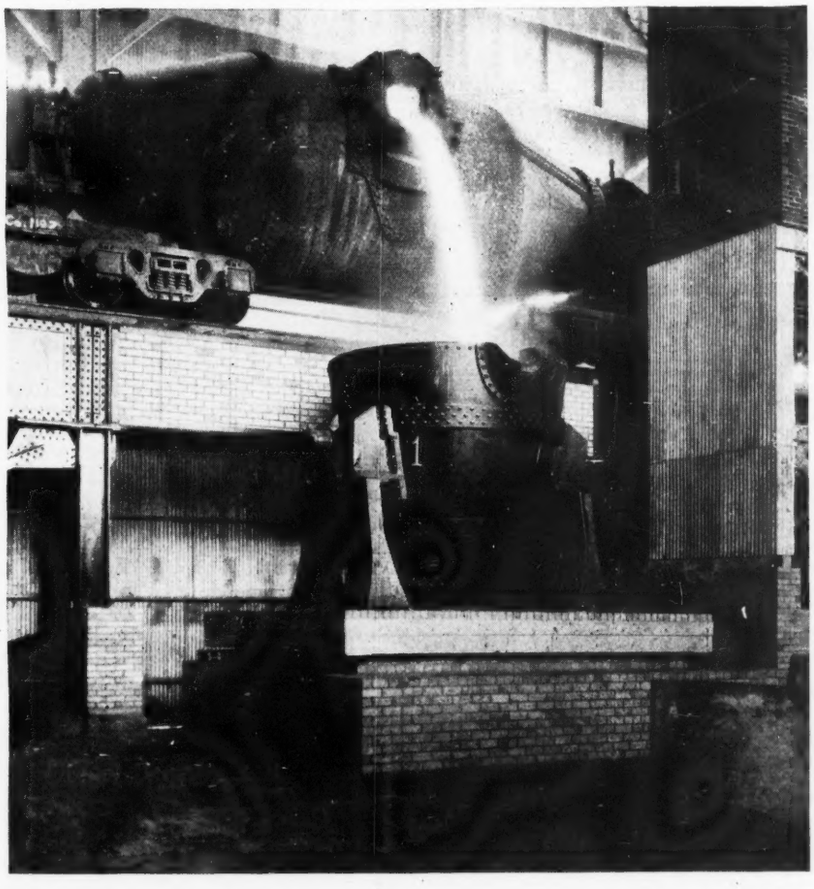
The linking of the American Rolling Mill Company and the Hamilton Iron & Coke Company by the transportation of a ladle of hot metal from the blast furnace at Hamilton to the East Works of Armco at Middletown, Ohio, by way of a special track built by the Baltimore & Ohio Railroad, marks the beginning of a new era in steel making in the Miami Valley. Not only in steel making, but also in railroad transportation and power applications, is this event widely significant. Molten metal will be carried daily over ten miles of track specially constructed for the purpose. Owing to the concentrated load of such large tonnage, it was necessary to design and build a special bridge over the Miami River having almost 50 per cent greater capacity than any other railroad bridge. It requires about 2½ hours to make a round trip to Middletown and there will be an average of four trips every 24 hours.

Three specially designed mixer ladles double-lined with firebrick are used to carry the molten metal, which can, when necessary, be held in the ladle 48 hours. The capacity of these ladles is 150 tons each. The metal is poured from the large ladle car into a small open ladle, from which it is poured directly into the open-hearth furnaces for the necessary refining process. This constitutes an important economy over the regular practice of charging cold pig iron into the open hearth, which practice requires many hours of high temperature to bring it to a molten state. The new practice saves much fuel, time, labor and wear on the furnace.

During the last winter, while the Hamilton Coke & Iron Company was constructing its new coke-oven plant near Hamilton, the Union Gas & Electric Company, of Cincinnati, was increasing its power transmission facilities and constructing a new 66,000-volt stepdown substation on the property of the Hamilton Coke & Iron Company, for the purpose of rendering power service to that new industry, as well as power and lighting service to the surrounding district. At the same time a new electrically operated gas compressor station was installed for the purpose of pumping coke-oven gas, manufactured by the Hamilton Coke & Iron Company, through its gas transmission pipe lines so that this new byproduct gas could be used in the Cities of Hamilton and Cincinnati, by mixing with natural gas being furnished through the high-pressure pipe lines of the Columbia System of Public Utilities.

Visitors attending the inauguration of this new transportation service met at Middletown and were conveyed by special cars over the Baltimore & Ohio Railroad to the blast furnace at Hamilton, where they saw molten metal taken from the furnace and sealed in the huge ladle. The return trip was then made to the East Works at Middletown, where the hot metal was poured into the open-hearth furnace for refining until it met the specified standard of purity.

At a luncheon given by the officials of the American Rolling Mill Company, President Willard, of the Baltimore & Ohio, President H. C. Blackwell, of The Union Gas & Electric Company, President H. P. Rust, of the Koppers Company, and others made short talks felicitating the American Rolling Mill Company and the Miami Valley on their contribution to industrial progress.



Molten iron has been transported ten miles in the ladle at the top of the picture. The pouring operation is controlled electrically.

McGraw-Hill Announces New Paper

The McGraw-Hill Publishing Company, Inc., has just announced it will publish, starting with the October issue, a new monthly to be known as *Food Industries*. The publication will be for the men interested in the manufacturing and processing of foods.

Food Industries will serve its readers by covering for them the technology of manufacturing food products, methods of food production, materials used in food processing and packing, materials of construction for equipment, handling of raw materials and finished products, research on food preservation and preparation, bacteriology, sanitation, improvement of processes and reduction of costs. In general, the paper will be devoted editorially to plant operation and production methods in the food industries.

Editorial direction of *Food Industries* will be under Dr. H. C. Parmelee, editor of *Chemical and Metallurgical Engineering* and vice-chairman of the editorial board of the McGraw-Hill publications, who will continue in those executive positions with McGraw-Hill. He will have as his editorial associates men selected from the food industries. Their names will be announced later.

M. A. Williamson, business manager of *Chemical and Metallurgical Engineering*, will be business manager of the new monthly. He will continue his present connection with *Chemical and Metallurgical Engineering*.

Boiler Explosion in Mexico City Does Great Damage

The boiler in a bathhouse of one of the poorer quarters of Mexico City exploded on June 20 with such force that the bathhouse and a building adjoining it, and two other buildings across the street, were reduced to débris. At this writing it is reported that 26 bodies have been removed from the ruins of the four-story building. Rescue workers fear that other victims are still buried beneath the ruins. Part of the boiler was hurled across the street destroying a dwelling and killing a mother and her two children.

It is reported by the police that the engineer in charge of the boiler had left the boiler to eat his lunch in another part of the building. The exact cause of the explosion and condition of the boiler before it was destroyed are at present not known.

OBITUARY

JOHN B. THOMAS, who has been identified with the Westinghouse companies for the last 52 years, died at his home on Thomas Boulevard, Pittsburgh, Pa., recently. At the time of his death he was assigned to special duty with the company. He was born in Wales, Oct. 6, 1852. He entered the employ of the Westinghouse company in February, 1876. In 1886 he was sent by George Westinghouse to Paris to manage the French branch of the air-brake company. He returned in 1888 and was transferred to the Westinghouse Electric & Manufacturing Company, with which company he remained until his death.

JAMES D. HURD, president of the New York Steam Corporation, of 280 Madison Ave., died June 23 at his home 770 Park Ave., after an illness of several months. He was 47 years old at the time of his death. He attended Hopkinson Smith School in Massachusetts and Harvard University, from which he graduated in 1903. He came to New York to become assistant secretary of the Guaranty Trust Company, which position he held until 1921, when he resigned to become president of the New York Steam Corporation. Mr. Hurd is survived by his wife and a son, James D. Hurd, 3rd.

PERSONALS

M. SPILLMAN, consulting engineer of the Worthington Pump & Machinery Corporation, delivered a lecture on June 19, 1928, to the staff of Stone & Webster, Inc., on the centrifugal pump, its possibilities and limitations in piping systems in general, with special reference to pumps serving in the generation and condensation of steam.

MAURICE A. OUDIN, vice-president of the International General Electric Company, Inc., who has returned from an extended visit in Europe, was signally honored by the King of Italy. In recognition of his good offices in behalf of a closer international relationship and of the specific benefit to the engineering profession of Italy, Mr. Oudin was decorated with the Order of Commander of the Crown of Italy.

CHARLES E. STROMEYER, O.B.E., is reported retiring after 30 years of service as Engineer-in-Chief to Manchester Steam Users' Association, and is to be succeeded by Telford Petrie. Mr. Stromeyer is well known as an English engineer and is a member of the Institute of Civil Engineers, Mechanical Engineers and Iron and Steel Institute. He has contributed a large number of scientific papers to these institutions and also to the Royal Society and International Congresses.

A. G. PRATT, president of the Babcock & Wilcox Company, and E. G. Bailey, president of the Fuller Lehigh Company, sailed for Europe on June 30 for a business trip.

HOWARD S. SCHALL, who has been connected with the Associated Buffalo Architects, has become associated with Harry P. Dempsey, consulting engineer, 232 Delaware Ave., Buffalo, N. Y.

R. E. TUNWALL has been elected president of the Davenport, Iowa, chapter of the National Association of Power Engineers. Mr. Tunwall will also serve as a delegate to the national convention in Detroit during September.

PAUL R. DUFFEY, electrical and power engineer with the Celanese Corporation of America at Cumberland, Md., is severing his connection with this company on August 1 in order to join the engineering staff of the Industrial Rayon Corporation, of Cleveland and New York, with headquarters at Cleveland.

GEORGE CLINTON WARD, executive vice-president of the Southern California Edison Company, received the honorary degree of Doctor of Science at Oberlin College June 19. This degree has been awarded only eight times by Oberlin and was conferred upon Doctor Ward in recognition of his work in applying the results of scientific research to the field of electrical and mechanical engineering. Doctor Ward has also received the honorary degree of Doctor of Engineering from the University of Southern California.

J. F. MCGILLIVRAY, after fourteen years of service in the engineering division of Armour & Company, has resigned to form the Tri-R-Service Company, 5254 West Monroe St., Chicago. This company will specialize on industrial research and power economy services.

BUSINESS NOTES

THE NAYLOR SPIRAL PIPE COMPANY announces a change in its name to the Naylor Pipe Company and also an increase in plant facilities of some 200 per cent. The new facilities make possible the manufacture of a new product under the trade name of Spiralweld Toncan Iron Pipe.

THE CHICAGO PNEUMATIC TOOL COMPANY, 6 E. 44th Street, New York City, has appointed George J. Lynch as district manager of sales at 1931 Washington Ave., St. Louis, Mo. Mr. Lynch was formerly assistant district manager in the New York office.

THE WALWORTH COMPANY has announced the transfer of J. J. P. Mackenzie, formerly assistant engineer in the engineering products division, to the Walworth Ohio Company as manager of its engineering sales department. Mr. Mackenzie has specialized in steel valves and fittings for high-pressure, high-temperature services, and was employed by a New York public utility corporation before joining the Walworth Company.

R. P. STEVENS, president of Stevens & Wood, which recently joined with Hodenpyl & Hardy to form the Allied Power & Light Company, has been elected vice-president, director and member of the executive committee of the Commonwealth Power Corporation, in which the new utility company owns a substantial interest.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY announces that J. K. B. Hare, recently manager of the Columbus, Ohio, office, has been appointed assistant central-station sales manager of that company. He will be associated with G. E. Wearn, central-station sales manager, and will have his headquarters at the company's office at 150 Broadway, New York City. Mr. Hare has been with the Westing-

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except **Pittsburgh gas slack:**

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.40@$2.60
Kanawha.....	Columbus.....	1.25@ 1.60
Smokeless.....	Cincinnati.....	1.75@ 2.25
Smokeless.....	Chicago.....	1.65@ 2.00
S. E. Kentucky...	Chicago.....	1.25@ 1.50
Steam.....	Pittsburgh.....	1.40@ 1.80
Gas Slack.....	Pittsburgh.....	1.10@ 1.25
Big Seam.....	Birmingham....	1.40@ 1.75
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$2.75@$3.00
Birdseye.....	New York.....	1.60

FUEL OIL

New York—June 21, f.o.b. Bayonne, N. J.: 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 7c. per gal.

St. Louis—June 19, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.45 per bbl.; 26@28 deg., $1.50 per bbl.; 28@30 deg., $1.55 per bbl.; 30@32 deg., $1.60 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 4.98c. per gal.

Pittsburgh—June 18, f.o.b. local refinery, 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., 5½c. per gal.

Philadelphia—June 20, 26@30 deg., $2.07 per bbl.; 13@19 deg., $1.22 per bbl.; 22 plus, $1.48@$1.55 per bbl.; 27@30 deg., $2.17 per bbl.

Cincinnati—June 19, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5¼c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—June 22, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 75c.@80c. per bbl.; 26@30 deg., 80c. per bbl.; 30@32 deg., $1.02½@$1.05 per bbl.

Boston—June 25, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.35c. per gal.; 28@32 deg., 5.65c. per gal.

Dallas—June 23, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

house interests for the last sixteen years and was connected with the company's Pittsburgh office prior to assuming management at Columbus.

THE CONSOLIDATED COAL COMPANY announces that its Baltimore, Md., sales office is now located on the tenth floor of the Fidelity Building.

THE ROLLER-SMITH COMPANY, 233 Broadway, New York City, has appointed John A. Coleman, 1006 Washington Avenue, Houston, Tex., to handle its sales organization in that state. Its sales organizations in the states of Colorado, Utah, Wyoming and northern New Mexico are now being handled by H. T. Weeks, U. S. National Bank Bldg., Denver, Colo.

TRADE CATALOGS

HIGH-SPEED HEAVY-DUTY DIESELS—The Busch-Sulzer Bros. Diesel Engine Company, St. Louis, Mo., has issued a new attractive catalog on its Type E high-speed two-stroke-cycle Diesels. This type of engine is built in several sizes up to a maximum of 1,200 hp. It was designed essentially to fill the demand for an engine weighing less than a slow-speed unit, while still retaining the ruggedness and reliability of the slow-speed Diesel. The catalog is amply illustrated with typical illustrations.

BROOKS DEFLECTION POTENTIOMETERS—In bulletin No. 763, recently issued by the Leeds & Northrup Company, Philadelphia, Pa., will be found a lot of valuable information on the Brooks deflection potentiometer. Applications of the instrument, its cost, accuracy and directions for its use are included.

WELDING—In the engineering Bulletin No. 206, issued by the Lincoln Electric Company, Cleveland, Ohio, two entirely different types of equipment for arc welding are compared. The two types of equipment are the variable-voltage, single-operator type, and the constant potential, multiple-operator type. The discussion covers the first cost of the equipment plus installation cost, the problem of interference between operators on multiple-operator sets, and economy of power of variable-voltage equipment.

DESUPERHEATERS—The cartridge type desuperheater of the Elliott Company, Jeannette, Pa., is described in bulletin No. 9, recently issued by the company. It consists of a simple shell with a series of water nozzles in the top cover. The body contains a removal cartridge of woven-wire construction adapted to retain water in its interstices and to bring water and steam into intimate contact with a minimum resistance to the passage of the steam.

SWITCHES FOR ACROSS-THE-LINE STARTING—A new bulletin of the Electric Controller & Manufacturing Company, Cleveland, Ohio, describes that company's line of type ZO switches for starting alternating-current motors having ratings up to 10-hp. capacity, by connecting them directly across-the-line.

INSULATING SUPPORTS—The Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill., has developed a new line of unit-type low-voltage spool insulating supports. These are fully described in bulletin No. 31-F.

LEATHER PACKINGS—In a four-page bulletin issued by the E. F. Houghton Company, Philadelphia, describing Vim leather packing, two pages are devoted to a review of "Common Troubles Encountered in the Application and Use of Leather Packings," giving a number of practical pointers on the use and care of leather packings.

NEW PLANT CONSTRUCTION

Compiled by the McGraw-Hill Business News Department, which is prepared to furnish a more complete daily service to those who wish it

Calif., Long Beach—E. Taylor is having plans prepared for a 14 story hotel including steam heating system, elevators, etc. Estimated cost $600,000. Traver & Jacobs, Lion Insurance Bldg., Los Angeles, are architects.

Calif., Los Angeles—Les Tours Building Corp., c/o A. E. Harvey, Black Bldg., Archt., awarded contract for an 8 story apartment building on North Rossmore Ave. to L. T. Mayo, Inc., Black Bldg. Estimated cost $1,000,000.

Calif., Napa—Union Ice Co., 354 Pine St., San Francisco, plans the construction of a pre-cooling plant at 7th St. and Soscol Ave. here. Estimated cost $300,000. Private plans.

Calif., Port Costa — California Water Service Co., Hunter-Dulin Bldg., San Francisco, is having surveys made for waterworks improvements including dam, pumping plant, etc. Thebo, Starr & Anderton, Sharon Bldg., San Francisco, are engineers.

Calif., San Diego—Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of a salt water pumping station at Naval Operating Base (Air Station) here to Robert E. McKee, 1128 Central Bldg., Los Angeles.

Ill., Chicago—R. DeGoyler & Co., 307 North Michigan Ave., Archts., will receive bids until July 10 for a 13 story apartment building, including central refrigeration plant, elevators, etc., at 78th St. and Rainbow Park, for W. C. Bannerman & Co., 77 West Washington St. Estimated cost $1,000,000.

Ill., Chicago—Plotke & Grosby, 111 West Washington St., awarded general contract for the construction of a 16 story apartment building at 5232 to 5242 Sheridan Rd. to Trimmer-Nydele Co., 111 West Washington St. Estimated cost $3,000,000.

Ill., Evanston—Cable & Spitz, 220 South State St., Archts., are receiving bids for an apartment building including central refrigeration plant at Sherman and Noyes Aves. for Nolin Building Corp., c/o architects.

Ind., Ft. Wayne—St. Joseph Hospital, is having plans prepared for a 7 story hospital including steam heating system, elevators, etc. at Berry and Van Buren Sts. Estimated cost $750,000. Pohlmeyer & Pohlmeyer, Central Bldg., are architects. Bevington & Williams, Knights of Pythias, Indianapolis, are engineers.

Mass., Ayer—Nashoba Cold Storage Co., c/o Haynes & Mason, 280 Main St., Fitchburg, Archts., awarded contract for a cold storage and packing plant here, to W. J. Handley Co., 280 Main St., Fitchburg. Estimated cost $65,000.

Mass., Bridgewater—Bd. of Education, State House, will receive bids about July 1 for rebuilding power plant at State Normal School. Estimated cost $80,000. E. D. Kimball Co., 6 Beacon St., Boston, is engineer.

Mass., Danvers—South Essex Sewer Dist., Fort Ave., Salem is having preliminary plans prepared for the superstructure of a pumping station here. Estimated cost to exceed $25,000. Smith & Walker, 80 Boylston St., Boston, are engineers.

Mass., Foxboro—Dept. Mental Diseases, State House, will soon receive bids for addition to power house and pump room at State Hospital. Estimated cost $40,000.

Mass., Marshfield—Bd. of Water Commissioners, is receiving bids for the superstructure of a pumping station. Estimated cost $40,000. Symonds & Stevens, 70 State St., Boston, are engineers.

Mass., Millbury—Millbury Steel Foundry Co., C. T. Lund, Pres., plans the construction of a 60 x 100 ft. power unit. Estimated cost $40,000.

Mich., Ann Arbor — Ann Arbor Savings Bank will receive bids about July 15 for an 8 story bank and hotel including steam heating system, boilers, elevators, etc., at Main and Huron Sts. Estimated cost $1,000,000. Pond & Pond, 6 North Michigan Ave., Chicago, Ill., are architects.

Mich., Ann Arbor—The Mediterranean Co., 202 Glen Ave., is having plans prepared for the construction of an apartment building including steam heating and refrigeration systems, boilers, elevators, etc., at Glen Ave., and Ann St. Estimated cost $3,000,000. O'Dell & Diehl, 710 Donovan Bldg., Detroit, are architects.

Mich., Detroit—Stott Realty Co., Lincoln Bldg., awarded general contract for a 35 story office building on Griswold St., to Martin Krausman Co., 955 East Jefferson Ave. Estimated cost $2,000,000. Steam heating and ventilation systems, boilers, elevators, etc., will be installed.

Mich., Lake Shore (mail Detroit)—Lake Shore Dist. No. 1, c/o G. J. Haas, Wormer & Moore Bldg., Detroit, Archts., will soon award contract for addition to school including new boiler house, etc.

Mich., Pontiac — Bd. of Education, R. Hazelton, Bus Mgr., will receive bids until July 9 for a school including boiler plant, on West Huron St. Childs & Smith, 720 North Michigan Ave., Chicago, Ill., are architects.

Mich., Royal Oak—City awarded contract for the construction of a booster pumping station at Livernois Ave. and Eight Mile Rd., to Lee Campbell & Son, 213 Royal Oak Savings Bank. Estimated cost $30,063.

Miss., Meridian—East Mississippi Insane Hospital, is having preliminary plans prepared for the construction of a hospital, ice and cold storage plant, power plant, etc. Estimated cost $225,000. R. C. Springer, Rosenbaum Bldg., is architect.

N. J., Netcong—Deborah Jewish Relief Society, W. L. Unger, Chn., 24 Branford Pl., Newark, is having sketches made for a 4 story sanitarium, including steam heating system, etc., here. Estimated cost $1,000,000. F. Grad, 1023 Broad St., Newark, is architect.

N. J., Newark—Branford Building Co., Inc., c/o H. F. Clark, 38 Clinton St., is having preliminary plans prepared for a 22 story office building including steam heating and ventilation systems, boilers, elevators, etc., at Branford Pl. and Arlington St. Estimated cost $3,000,000.

N. Y., Long Island City—Janbous Electric Co., L. Freed, Pres., 220 East 40th St., plans the construction of a 6 story apartment building at Greenpoint Ave. and Van Buren St. Estimated cost $1,000,000.

N. Y., New York — A. N. Adelson, 65 West 36th St., is having preliminary sketches made for a 44 story office and department store at 58th St. and 5th Ave. Estimated cost $9,000,000. Architect not selected.

N. Y., New York—L. Adler, 550 7th Ave., is having preliminary sketches made for a 35 story office and loft building. Estimated cost $7,000,000. Buchman & Kahn, 49 West 45th St., are architects.

N. Y., New York — S. Mayer, 41 East 72nd St., had plans prepared for a 16 story apartment building at 200 East 68th St. Estimated cost $1,300,000. G. & E. Blum, 415 Lexington Ave., are architects.

N. Y., White Plains—Westchester County Bd. of Supervisors, awarded contract for the construction of a psychopathic hospital to John Keil, 151 Main St., Ossining. Estimated cost $600,000. Steam heating and ventilation systems awarded. New bids will be received on refrigeration system.

N. C., Tarboro — City Commissioners plans extensions and improvements to power plant. Estimated cost $100,000.

O., Cleveland — Cleveland Athletic Club, c/o J. B. Smith, Secy. and Treas., 1118 Euclid Ave., is having sketches made for a store and office building. Estimated cost $1,000,000. Walker & Weeks, 2341 Euclid Ave., are architects.

O., Orrville—Bd. of Public Affairs, A. D. Webster, Supt., will soon receive bids for reconstruction of boiler room for municipal water, ice and electric plants. Estimated cost $17,000.

O., Toledo—Bd. of Education, R. W. Wenzlau, Dir. of Schools, will soon award contract for the installation and completion of a heating plant at Fulton School, Fulton and Delaware Aves.

Ore., Electric Park (mail Corwin Springs) —Grays Harbor Railway & Light Co., awarded contract for the construction of a 10,000 hp. steam generating plant to Sanderson & Porter, 52 William St., New York, N. Y. Estimated cost $1,500,000. Work will be done by day labor.

Ore., Eugene—Eugene Water Board, C. A. McClain, Supt., awarded general contract for the construction of Leaburg hydroelectric development on McKenzie River, Cont. F. headworks, Cont. G., canal and tailrace and Cont. H. forebay, penstocks, siphons and power house No. 2 to A. Guthrie & Co., Sherlock Bldg., San Francisco, Calif. $1,029,230. Contracts let on equipment as follows: turbine, 10,000 hp. to S. Morgan Smith, York, Pa., one 7,500 kva. generator, six 2500 kva. transformers and exciter to Westinghouse Electric & Mfg. Co., 30th and Walnut Sts., Philadelphia, Pa. three 100 ft. roller gates to Williamette Iron & Steel Works, Ft. Front St., Portland and one 30 ft. sluice gate, two 24 ft. canal gates, two 18 ft. penstock gates to Philips & Davies, Kenton, O.

Tex., Dallas—City and County of Dallas Levee Improvement Dist. Supervisors, J. J. Simmons, Chn., and Dallas County Levee Improvement Dist. No. 5, S. C. Pratt, Chn., awarded contract for the construction of pumping plants, etc., in connection with reclamation project to Trinity Farm Consruction Co., Southwestern Life Bldg. Total estimated cost $6,500,000. Construction will be under the supervision of Morgan Engineering Co., Goodwyn Bldg., Memphis, Tenn., consulting engineers, in association with Myers, Noyes & Forrest, Mercantile Bank Bldg., Dallas, engineers of district.

Tex., Littlefield—City awarded contract for a 100,000 gal. underground storage tank to A. Neuenschwander. Estimated cost $25,000. Will be equipped with a two unit booster pump.

Tex., San Antonio—J. X. Newcombe, c/o Blue Bonnett Hotel, awarded contract for the construction of an ice plant to Moeller & Weilbacher, 1219 Willow St. Estimated cost $35,000.

Tex., Fort Sam Houston (station San Antonio) — U. S. Government, War Dept., Washington, D. C., c/o A. W. Parker, Quartermaster, Fort Sam Houston, is receiving bids for the construction of a 20 or 25 ton ice plant. Estimated cost $35,000.

W. Va., New Martinsville—City plans an election July 1 to vote $124,000 bonds for the construction of a municipal electric light and power plant. R. Husselman, Union Trust Bldg., Cleveland, O., is engineer.

Wash., Seattle—City Council, appropriated $991,500 for the construction of a power project including sub-station, lighting department offices, equipment, etc.

Ont., London—City Council, is having plans prepared for extensions and improvements to heating plant, also plans a new boiler house, etc. at Victoria Hospital. Estimated cost $40,000. W. P. Near, City Hall, is engineer.

Ont., Powassan—Hydro Electric Power Commission of Ontario, 190 University Ave., Toronto, plans the construction of a hydroelectric development at Elliott Chutes on South River, near here, 1,800 hp. capacity, probably two units, to include dam, power house, turbines, generators, transformers, etc. Estimated cost $300,000. F. A. Gaby, 190 University Ave., Toronto, is engineer.

Ont., Toronto—Canadian National Exhibition, Lumsden Bldg., awarded contract for an engineering and electrical exhibition building at Exhibition Park to Sullivan & Fried, 81 Victoria St., Estimated cost $750,000.

Ont., Toronto—Toronto General Hospital Board, 101 College St., awarded contract for a 9 story hospital on University Ave. to W. H. Yates Construction Co., 95 King St. E. Estimated cost $1,500,000. Steam heating and ventilation systems, elevators, etc. will be installed.

Equipment Wanted

Air Compressor, Pumping and Softening Equipment, etc.—City of Brownsville, Tex., A. E. Mundy, Secy., will receive bids until July 20 for airport equipment including air compressor, pumping and softening equipment, etc.

Boiler—Bd. of Public Affairs, Orrville, O., plans the installation of a boiler (later) for proposed reconstruction of boiler room.

Boiler—City Council, London, Ont., plans the installation of a 400 hp. boiler for proposed new boiler house and heating plant addition. Estimated cost $40,000.

Boilers, Generators, etc.—Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., Columbus, O., plans the installation of boilers, generators, etc., in proposed power house at Institution for Feeble Minded, Apple Creek, O. Estimated cost $40,000.

Diesel Electric Equipment—Dept. of Mental Hygiene, L. M. Farrington, Secy., Albany, N. Y., will receive bids until July 6 for equipment for two double end steel Diesel electric ferryboats for Manhattan State Hospital, Ward's Island, N. Y.

Elevating and Conveying Equipment — James Playfair & Co., Midland, Ont., elevating and conveying equipment, electrically operated for proposed grain elevator, 74 x 470 ft., 100 ft. high at Toronto, Ont. Estimated cost $500,000.

Engine—City of Princeton, Ill., plans to purchase and install a Diesel engine for waterworks to cost $45,000.

Engine, Etc.—Treasury Dept., Office of Supervising Architect, Washington, D. C., will receive bids until July 19 for a new engine, etc. for Lepers Home, Carville, La.

Power Plant — Engineers Office, War Dept., Washington, D. C., will receive bids until July 7 for the installation of one complete Diesel electric power plant.

Pumping Equipment—Town of Newton, Sussex County, N. J., H. D. Masters, Clk., will receive bids until July 16 for pumping equipment, etc., for proposed sewage treatment works.

Pumps — City of Niagara Falls, Ont., electric centrifugal pumps, etc., for proposed filtration plant for Niagara Falls Water Comn. Estimated cost $400,000.

Pumps—City of Bismarck, Mo., one 250 g.p.m. motor driven, one 250 g.p.m. engine driven pumps, also one 100 g.p.m. deep well pump, etc., for proposed waterworks improvements.

Pumps, Etc.—City of Sacramento, Calif., plans the installation of one 25 m.g.p.d. high lift pump, and one 25 m.g.p.d. low lift pump with motors and appurtenances, for proposed waterworks improvements. Estimated cost $688,000.

Refrigeration Equipment—Bd. of Education, 305 City Hall, Minneapolis, Minn., F. S. Cram, City Purch. Agt., will receive bids until July 2 for refrigeration equipment for North High School.

Refrigeration Plant—State Bd. of Administration & Finance, 10 State Capitol, St. Paul, Minn., H. W. Austin, Purch. Agt., will receive bids until July 6 for the installation of a refrigeraiton plant at State Hospital for Insane, St. Peter, Minn.

Industrial Projects

Calif., Los Angeles—GLASS FACTORY—Illinois-Pacific Glass Co., E. C. Pierce, Local Mgr., 3101 Fruitland Ave., had plans prepared for the construction of a group of factory buildings on Vernon St. Estimated cost $400,000. Private plans.

Ind., Ft. Branch—PACKING PLANT—Emge Packing Co., awarded contract for the construction of a packing plant to Scarborough & Davis, 710 Old State Bank Bldg., Evansville. Estimated cost $100,000.

Ind., Fort Wayne—FACTORY—Wayne Knitting Co., awarded contract for the construction of a factory and boiler room, etc. to Indiana Engineering Co., 201 Central Bldg. Estimated cost $50,000.

Kentucky — CEMENT PLANT — F. B. Drew, McAlister, Okla., R. W. Hunt Co., 303 Orear Leslie Bldg., Kansas City, Mo. and L. Hunt, New York, N. Y., plans the construction of a cement plant here (location not decided). Estimated cost $1,750,000.

Mich., Detroit—RESEARCH LABORATORY—General Motors Corp., General Motors Bldg., awarded contract for an 11 story, 210 x 255 ft. research laboratory at Cass and Baltimore Aves. to Everett Winters, 1651 East Grand Blvd.

N. J., Newark—LEATHER FACTORY—J. Lichtman & Sons, 241 Frelinghuysen Ave., awarded contract for a 4 story, 178 x 218 ft. leather factory at 306-36 Sherman St. to J. F. Mitchell Co., 30 Church St., New York, N. Y. Estimated cost $350,000.

N. Y., Mariners Harbor (Staten Island P.O.)—OIL REFINERY—Gulf Refining Co., 21 State St., New York, subsidiary of Gulf Oil Corp., has acquired a tract of 600 acres here and plans the construction of an oil refinery comprising nine units, power house, machine shop, etc. Facilities will be provided for handling crude oil from seagoing tanks including pumping machinery, etc. Estimated total cost approximately $20,000,000.

N. Y., Syracuse—FOUNDRY—U. S. Hoffman Machinery Corp., 329 Temple St., awarded contract for a 2 story foundry, to Dawson Bros. Construction Co. Estimated cost $60,000.

N. C., Charlotte—PAPER BOX FACTORY—Charlotte Paper Co., 214 South College St., plans the construction of a factory. Estimated cost including equipment $100,000.

N. C., Leaksville—CARPET MILL and STORAGE WAREHOUSE—Marshall Field Co. awarded contract for a 100 x 152 ft. addition to Homecrest carpet mill including enlargement of boiler room to take care of extra boilers, to J. M. Hopper Construction Co., also a 60 x 100 ft. storage warehouse to John Smith, Leaksville.

O., Kent—GARMENT MANUFACTURES FACTORY—C. G. Kistler, Archt., is receiving bids for the construction of a factory and boiler house for I. N. Gross Co., M. E. Reed, 1220 West Third St., Cleveland. Estimated cost $75,000.

O., Scienceville—LIGHTING FIXTURE FACTORY—Radio Electric Co., plans the construction of a factory on Liberty Rd. Estimated cost $40,000.

Pa., Philadelphia—MACHINERY FACTORY—E. H. Poggi, Mitten Bldg., Archt., will receive bids until June 22 for a 2 story, 104 x 107 ft. factory, etc. for York Ice & Machinery Corp., Belmont and Thompson Sts.

Wash., Port Townsend—PAPER MILL ADDITION—National Paper Products Co., ft. of Main St., Seattle, plans the construction of an aditional second unit to paper mill, here.

Wis., Appleton—PAPER PLANT ADDITION—Appleton Paper Co., plans the construction of a 1 story, 107 x 240 ft. addition to paper plant. Lockwood, Greene & Co., 400 North Michigan Ave., Chicago, Ill., are architects.

Ont., Mount Denis — BOX FACTORY — Firstbrook Bros., 283 King St. E., Toronto, plans the construction of a box factory here, including steam heating system, etc. Estimated cost $300,000. Architect and engineer not selected. Motors and box manufacturing equipment will be required.

Ont., Peterborough—ELECTRICAL MANUFACTURING BUILDING — Canadian General Electric Co., 212 King St. W., Toronto, plans a 2 and 3 story, 100 x 228 and 90 x 100 ft. electrical building here. Estimated cost $300,000. Private plans.